Interview with

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Early Years

Q: As I explained, I'm going to start a series of questions starting from your childhood and try to take you through your whole career. That is just my approach. Do not just stop an answer, just continue and say whatever you want to say, whatever thoughts you might have.

Can you tell me a little about your family background and your childhood?

A: Well, I was born in Roseau, Minnesota in a small northern community in Minnesota and my family--[there were] three children in the family--myself and brother and a sister. About the time I was four years old we moved to North Dakota to a small town named Cando, North Dakota. Then, after graduating from high school, my family moved to Bozeman, Montana where I attended one quarter of college before I was drafted in the Army. I spent just slightly less than two years in the Army and after that went to school at Montana State University. I graduated there in 195 1.

Q: Okay. Let me take you back to your high school for a minute. Were there any teachers that you had that particularly influenced your decision to go into engineering?

A: Well, in those days we didn't really get much information on what engineering was all about, really, in high school. In the high school I went to you got mathematics, and I was interested in math and science more than I was some of the other courses like English and biology, for example. But I really didn't have a good comprehension of what the various types of engineering were and what each one of them did. I knew that you built bridges and all that kind of stuff and houses and large buildings and that sort of thing in civil engineering, but that is about all I knew about it.

I knew there was such a thing as chemical engineering and mechanical engineering and electrical engineering, but I really didn't have a good fix on which--I thought I would like

to be in engineering, but I didn't know just what field of engineering even after I started college. After I got out of the Army, I enrolled in electrical engineering because I had been a radar repairman while I was in the service. I went to service school and learned how to be a radar repairman. So with that electrical background--electronics background--why I thought maybe electrical engineering would be the right field for me but after a year or so of that I decided that wasn't right. So I went into--moved over to civil engineering.

The Army and Montana State University

Q: You were drafted into the Army after high school?

A: Right.

Q: So you were in from January 1945 until August 1946. Were you in a Signal Corps unit?

A: No. Well, I first went in the infantry. I went through an infantry basic and some advanced infantry training. Then I got sent over to Hawaii. Actually we were en route to Okinawa as replacements for the infantry that were going to go in on Japan when they attacked Japan.

About that time marry S] Truman decided that he was going to drop the atomic bomb, so we didn't even go to Okinawa. They dropped us off in Hawaii. A couple of months later they dropped the bomb on Japan. Otherwise I would have probably been in there on an assault ship trying to get into Japan.

Q: Which would not have been happy for a lot of people.

A: Right, that's for sure.

Q: When you decided to go to Montana State, was that because your family was in Montana now?

A: Yes, that's true.

Q: A lot of the people I've talked to who became civil engineers in the '50s, credited their ability to become engineers to the GI bill. Did you go to college on that basis, too?

A: Right, that's true. After I got out of the service all of my work--until I graduated--I got on the GI bill.

Q: Now you started in electrical and you switched after a year. What inspired you to go into civil?

A: Well, I learned more about what the various types of engineering did, and I felt that I was more interested in what civil had to offer. I had a professor in charge of civil engineering, Dr. [Eldon] Dodge, who pointed out that he had a series of seminars that all of the students had to take which he talked about professions and just a practical lecture. There was no course work other than just coming and listening to what he had to say about how to go about dealing with your profession and deciding on what you want to do, and things like that.

He pointed out that a lot of graduating engineers actually didn't work in the field they got their degree in. They would change their mind after they had graduated from college and because of opportunities or other reasons they would work in a different area then they actually got their bachelors degree in. Or they would go on and take advanced degrees in some other type of engineering.

That was really one of the most beneficial courses that I think I had in the whole school--listening to him talk about how to find a job and where to work if you were a civil engineer. "Be careful that you don't get into an organization that is run by lawyers and the engineers are in the back room some place. Be sure that in the organization that the engineer's role is a prominent role." All that type of thing that you didn't get anywhere else because he had been in private practice before he became a professor. So he had a lot of background in that area, and he could provide a lot of good guidance. It got a lot of us started off in a good direction I think.

Q: So you had a lot of practical experience from him, where he had been and the same problems and that was really critical. Did you find that a lot of your professors had never been out consulting or working for architect and engineering firms?

A: Well, the majority of them had not been. We had the head of the department and then there was another one that came in while I was there who was a surveying instructor, who came from private industry. He had a lot of practical experience that he brought to the classroom. He taught courses on construction, which was really his course. The construction industry thought that his students were really great because he gave them so

much practical background on the construction work that they were far better than the students from some other school that didn't have that kind of practical knowledge and the experience of the instructor's life.

Hydrology and Hydraulic Engineering

Q: Why did you become interested in hydrology and hydraulic engineering?

A: Well, it [was] my first exposure to working with the government actually. I had odd jobs in high school and so forth, working on a farm, and all that kind of stuff. But when I was going to college my father was a heavy equipment operator and he worked for the Bureau of Reclamation [BuRec]. So he got me connected with the engineering people there, and I was able to get a couple [of] summer jobs working in the soils area.

So I worked in the soils area. Jobs were tough to get when I graduated, to tell you the truth The Bureau of Reclamation, since I had been working for them for two summers, they just assumed I was going to come to work for them after I graduated. They didn't even come after me or anything. I really had to take off from school to go and find out if I could go to work for them. They had never really even taken me off their rolls. I was still one of their employees, which really was to my advantage when it come to retirement because I got extra credit. But I was just on leave without pay when I was going to school, after the first day I started working for them.

But, anyway, they had a few opportunities, while limited opportunities you might say, where I could work when I got through school. There weren't very many other offers around. I had a chance to go to work for Boeing, but I didn't think that I'd want to be in the aeronautics type design.

So I took the job with the [Bureau] and just happened that the job in hydrology and hydraulics sounded more interesting than the other jobs. And after I started work from there I really enjoyed it.

Q: So you didn't have any course training at all beyond the basic BSCE [Bachelor of Science Civil Engineering] work in hydraulics?

A: No. Well, you mean to have the normal courses. This professor that was in charge of civil engineering taught a course on hydrology which was practically non-existent at that time in most schools. But he had even written a book which was in draft form that didn't get published because about the time he was ready to publish another couple of them came

out so he just decided not to publish his.

But he gave us a lot of good information on hydrology and we learned a lot about what it was--I knew what hydrology was all about because of that course. So I knew enough about it so that I felt at home working in there.

Q: Now who was your professor there that taught that?

A: His name was Eldon Dodge. He was the head of the Civil Engineering Department.

Q: So he's the same person who gave you the introduction.

A: Yes. He was a tough guy, I'll tell you, but he taught us a lot.

Q: Well, like you said, there certainly were at that time very few courses and very few people who specialized in that. Was he trained by any of the leading American hydrologists or hydraulic engineers, do you know?

A: I'm not sure--he worked in Wisconsin for a hydraulics firm. So he apparently got his hydrology and hydraulics background from that firm that he worked with. I don't remember the name of it.

Q: But he didn't come from CalTech or MIT or Iowa?

A: No, U. of Wisconsin.

Q: With the BuRec, what projects did you work on?

A: Well, let's see--Yellowtail Dam. I worked on some projects that never got built. A couple of dams on the Powder River, Moorehead Dam and a couple of others that they had proposed but never did get constructed. Things like power studies on Yellowtail Dam. Trying to decide on what was the proper amount of power to put in the project and all. Those were some of those long, tedious type jobs that don't take near that much time anymore.

Q: Now is that where the computers today would do a lot of your calculations?

A: The computers today make that very easy. The sad part about those old computations is you didn't learn anything when you were doing them. You would sit there day after day after day working on the same kind of a problem, doing the same numbers over--number crunching over and over--and you weren't learning anything. It was not a very good experience except that since there weren't a lot of jobs around there anyway, you couldn't be too particular about where you worked.

Q: You had to put bread on the table.

A: Yes.

Q: What did you use to do your calculations? Did you just use a pencil and paper, a slide rule, the basic calculators?

A: We had the electronic desk calculators. Frieden was, I think, one of them. But, you know, there is an interesting thing about that. I moved to Fort Peck after I worked for the Bureau of Reclamation for a while. But there was one of the fellows there that used one of these hand-cranked computers. He wouldn't use the electric operated computers. He would punch in his numbers and turn the crank and get the answers and he just wouldn't use anything else.

Q: He didn't trust the electronics?

A: I guess not. I don't know, I never could figure out why he wouldn't use the other calculators.

Q: Were there any people at the BuRec where you were working who particularly influenced your focus in hydrology or for you to go into it. ? Or was it just the work, you liked the work?

A: Well, I just liked the work and the people were very interesting, too. I had a good boss. I worked in a district office in Billings, Montana, and they also had a regional office there at the same time. The fellow in charge of the regional was named Phil Gibbs. He kept me interested in the field, I'd say, for one thing.

Q: What is always interesting to me are the personal relationships you develop with people and how they can shape your career as far as what you study and your interest in subjects. Was Mr. Gibbs in that category?

A: He and my immediate supervisor, Ed Hower, he was very supportive. Actually, he didn't have the technical capabilities that Phil Gibbs had. But he was a good manager and he tried to make opportunities available for us when he could, and to make our jobs interesting. We used to get to go on a lot of field trips and do a lot of visiting with people, ranchers and so forth. Going out and looking at irrigation projects and checking where water was being diverted and that type of thing.

We'd go up in the mountains and take pack animals and horses and go up there and spend a week or two. About all we'd eat were trout which we caught fly fishing. We'd do some surveying while we were up there and stream gauging, and things like that. So it was a pretty interesting job.

Q: Sounds like a lot of fun. You were doing your job and having a vacation at the same time.

A: Just about it.

Backwater Studies

Q: So those were the field investigations. You just took those observations, or the data you collected up there, and you'd bring it back and make your reports on that basis?

A: Right. We'd use that data to do the computations. We'd have to do backwater studies, and we needed cross sections of the channel and we needed to know what kind of flow, we'd get rating curves for the channels, what to plot, stage vs. discharge. We'd do that with these stream gauge measurements. We'd need profiles of the stream bottom to know what the slope of the stream was and that type of thing.

Q: Now that's how you figured out the volume that flowed through the area and the sedimentation and all that?

A: Well, that's part of the process--you use all that various data you get to help you make the different types of hydrology and hydraulics computations.

Q: You've mentioned backwater studies several times, would you want to explain what they are.

A: Well, a backwater study is trying to find out what the water surface profile looks like for various discharges. What you do is you start with an estimated elevation at a lower cross section. Take cross sections out of the stream so that you know what the shape of the channel and the overbank area look like. Then you start with the water surface down at the lower reach, and you step- by-step you go from one cross section to the next.

As you move upstream the first couple of cross sections probably won't be too accurate unless your initial water surface was real accurate. But as you move upstream you'd become more and more accurate. It dampens out the poorer accuracy as you start off and so that you end up with a good water surface profile upstream. For example, if you want it in the flood insurance program, which I'm working with now, you need to know what area is covered by the 100-year flood.

First of all, you have to know what the water surface profile is for the 100-year flood. Then you take that elevation horizontally from the stream until you reach the ground at that same elevation, and that's the limit of the flooding. Then you'd draw the outline of all that area between the cross sections. Then whatever is in that area is considered the 100-year floodplain.

The flood insurance people require communities involved to force the residents to prohibit building in the floodplain and other agencies and other programs force people to buy flood insurance. Mortgage people say if you're going to get a mortgage from us for you to live in the floodplain, you're going to buy flood insurance. So that's part of the program. But that is a primary use for backwater studies.

Then another thing you use those for is to get what I called rating curves before. You draw a curve that shows elevation on one limb and discharge on the other. You'd get a curve so that you can use that curve to estimate other elevations for other discharges than the known ones. You need that downstream from dams to compute your hydraulics to design your outlet works and to decide on how much hydropower you can get out of the dam.

Hydropower is based on the volume of water as well as the head you have on it--the head downstream and upstream. They are the primary two things that decide on how much power you get out of dams. You need that backwater relationship so that you establish the tailwater elevation and the headwater elevation, that difference in elevation at the same time gives you the total head that you use in your computations. But, anyway, those are

uses for backwater.

Another thing that backwater profiles give you. In designing levees you need to know what the top of the levee should look like. You use that water surface or whatever design flood to decide on the top of the levee. You put freeboard above the water surface so that waves won't go over.

Q: Now you were working in the upper Missouri area at that time.

A: Right.

Benefit/Cost Ratios

Q: The early '50s was before they really had all the big main stem dams in up there. So you had a lot of flood calculations to do then?

A: Right. Well, I first worked for the Bureau for a little while. Of course, the Bureau doesn't do flood calculations. When the Bureau of Reclamations builds a dam and it has flood control storage, they go to the Corps of Engineers to find out what the benefits are from whatever storage they can make available for flood control.

So they don't actually do the flood computations in the Bureau of Reclamation. They have to go to the Corps. The Corps has responsibility for flood control. So they go to the Corps to get that. Likewise, if the Corps has any irrigation in one of the projects that they were building, the Bureau of Reclamation would take care of deciding how much benefits there were connected with it, who got it and all that sort of stuff.

Q: Now that's a particularly significant subject isn't it--the whole area of benefit/cost (B/C) ratios?

A: Oh yes. It has even become more and more of a concern to the Executive Branch of the government and to the Legislative Branch, too. They want to be sure that the federal funds we invest in water resources have a pretty good chance of providing equal or more benefit. Otherwise they don't want to invest the money. They do benefit/cost analysis on almost everything. Not just water resources but all kinds of things, they try to figure out whether they're going to get equal returns from the money they invest.

Q: When you first were with the Bureau and the Corps, benefit/cost was significantly different than it is now, wasn't it?

A: Right. Now they've made a lot of sophisticated changes in benefit/cost analysis. Whether they're getting any better at answers or not is maybe questionable but at least it looks better. The sophistication makes it appear like we are getting better answers.

Q: But as far as I understand it, isn't it mostly to tighten up, to make fewer projects available by making many more criteria?

A: Different people have different motivations for it. But obviously a Congressman who has a potential project in his backyard, he isn't really so concerned about the benefit/cost ratio as his colleague is in another part of the country who doesn't want to put out funds for that guy's area unless he's dang sure that it is a good investment. So, it depends on what seat you're in whether you're concerned about it or not.

But, anyway, the whole idea was when they went through many of these Congressional committees and inter-agency committees to come up with ways of doing benefit/cost analysis. They wanted to be consistent. The big problem was that everybody was doing it different. They wanted to have a common approach to establishing the adequacy of water resource projects.

And, of course, they didn't. They don't just use economics in deciding on whether a project is worthwhile or not. They talk about maximum net economic benefits. Then they talk about maximum net benefits. There is a difference between the two of them because it's just hard to quantify the intangible benefits like preventing loss of life or reducing a risk to the people downstream, inconvenience, reducing inconvenience, and all that kind of stuff. It's hard to put a dollar value on it.

When you're doing one of these analyses you have a hard time explaining why this project is really better than what the benefit/cost ratio says on it. You have to do it in words, it's hard to do it in dollars and many people have attempted to do it. It's pretty hard to convince anybody else that your computations are worth while.

Q: Isn't that one of the problems that the Corps ran into with recreation--how do you compute the benefit of recreation from all these multiple-purpose developments?

A: Well, they had a hard time doing that but they did get to the point where, after making a lot of surveys and studies that people are using recreational facilities, they were able to

assign what kind of money a person would spend on a day at the lake. They would interview people and say, "What did you come to the lake for?" [Some] said, "I come to fish." They'd say, "Well, how much money do you spend?" [They'd] ask them to fill out a questionnaire and say "How much money did you spend to come here for a day of fishing?"

After interviewing a lot of people, they got a pretty good idea of how much an individual person would invest to spend a day at the lake. Now, if a person is willing to spend that much money to come to this project for two weeks, then that's a benefit to society. If you didn't spend it here, you'd spend it someplace else.

With those kind of surveys and analyses, they were able to say, "Well, we have been keeping track of the people that came there." They got a sample of how many come for fishing, how many come for just an outing for the day, or something like that. With the proper mix why they were able to then say, "Well, 30 percent of the people come here for a picnic, 50 percent of them come to fish, 10 percent just for a boat ride." You know, different things like that.

Then knowing the benefit for each one of these things, they could then come up with a total benefit for the project. But then there are a lot of other complicated things that have to get in there, too. How far away will these people come from? If they've got a lake here and there is no other lake around for 200 miles then they have a draw from a bigger segment than if there was all kinds of lakes and not very many people. So they've got to take all those things into consideration.

Irrigation vs. Flood Control

Q: I know it's a very complex, like you say, sophisticated approach. On the upper Missouri, did you run into any particular problems that you had difficulty coming to conclusions on? I don't mean projects that didn't make it, but engineering problems that you ran into when you were working with BuRec. Problems for which you had difficulty in finding solutions?

A: Well, some of the things that you need to estimate are very difficult when it comes to deciding the operation and the management of the storage you have available in reservoirs. For example, when you're in that part of the country a good share of the runoff that you get comes from snow-melt. Okay, now if you can forecast how much runoff you're going to get, say early in the year in January, you can start filling the reservoirs up or you can capture that snow runoff. If you've got a lot of snow and you know pretty much how

much runoff you're going to get, you can start drawing down your reservoir to prepare it to catch the runoff.

Then, if everything worked perfect you would forecast how much runoff you were going to get, and you'd draw the reservoir down and then the inflow that came in would exactly fill it back up to the top of your irrigation pool by the beginning of the irrigation season, if everything would be hunky dory. But what happens if you make a wrong forecast and you say that there is going to be a lot more water coming off then actually comes off, then you draw down too low and at the beginning of the irrigation season you don't have as much water as you should have.

Where on the other hand if you make a forecast that is too low and you don't draw the reservoir down far enough, then you can't take care of the flood and somebody gets flooded because you didn't have enough storage to control it. So getting the exact balance, forecasting that, is really a tough job. We used to work and work on forecast equations based on what had happened in previous years, and you'd come up with regression equations, taking into account all kinds of things like rainfall and temperature, antecedent runoff, and other pertinent information.

You'd find equations that would maybe hit 95 percent of the time. But then there -would be one year that nothing seemed to work on. It would be way off no matter what you did with the general equation that you were coming up with. I believe, let's see, on the Colorado River I think it was--I'm trying to remember what year it was. I believe it was 1952--no, no, that wasn't it. It was after they had filled up the conservation storage in Glen Canyon. Anyway, it was before I retired. Maybe it was '82, that sounds more like it--maybe '82.

The forecast was way off because what happened is they got a real late snow in the year. It was real late, like a real heavy snow which they hadn't predicted earlier, therefore they hadn't drawn the reservoirs down very much or anywhere near as much as they should have based on this later snow. Then it got real warm right after the snow, and they got a lot of runoff. There was quite a bit of flooding and a lot of damage to some of the Bureau projects from that big flood.

They had a tough time--they were very lucky that they didn't have even more damage because of the fact that they hadn't been able to draw down, or didn't contemplate this, or had no way of forecasting it. There was a lot of criticism about the whole thing on the lower Colorado because there was all kinds of recreational facilities down there along the river, and they were getting much higher releases than they had ever gotten before.

Of course, they had benefitted from many years where they were filling up the reservoirs.

They were big dams and took a lot of water to fill up the conservation storage. So those years that they were filling up the conservation storage, why they never had any floods downstream. Had all kinds of extra storage so they didn't have to worry about floods while they were filling up.

Well, once they got full, why then they had to start doing this annual operation I was talking about. When you do, many people get involved in deciding what the operation of a major reservoir should be because you've got the people that live around the reservoir. They don't want to be flooded by the reservoir being too high.

You've got power interests who don't want any water going out of the project unless it goes through the powerplants because they're afraid of losing money. You've got the irrigation people, they want the storage as full as you can get it so they have lots. While the flood control people want it down as low as they can get it so you have lots of water for flood control. Trying to coordinate all those interests together and get the right mix. . .

The fellow that taught me the most about that was named Emil McLendon, and he was in charge of water control management for the Missouri River Division when they had all those big projects on the Missouri River. He was a very sharp man. But he learned early on in his operation management of those reservoirs. I don't know, maybe he learned it from his boss, too--Tim Wora, who was his previous boss. But they were the first ones that really got involved in that upper Missouri water control management.

They learned early on to get all the interests together in making decisions. Don't try to do it by yourself. Like the Corps people try to make all the decisions and then tell the other people how it is going to be done. Because everybody will be screaming at them.

So what they did, they started off with the idea of having these operational meetings that they would have. They would come up with a preliminary plan for operating the reservoirs. Then at this meeting, why all of the interests from power, irrigation, states, competition among states and all this sort of thing. All the state representatives would be there. They would lay out their preliminary plan for how they were going to operate the reservoir for that next year based on what the pool levels were at that time and what was expected.

If one person, for example, if the fellow from the irrigation interest would argue strongly, "Hey, you're not storing enough water," why immediately the flood control interest would jump up and say, "The hell they're not, they're storing too much or something like that." So they'd get all these people, and they'd usually end up getting their preliminary plan approved because they didn't have to argue with the people that objected to it. The other

people, they argued with each other.

They finally realized the importance of the other guys' point of view, too. When they got in a room, then the irrigation man had to convince the flood control man why his point of view was so important. Anyway, they used to be pretty interesting sessions.

Q: Was that Missouri Valley Basin Association or compact there in the upper Missouri basin?

A: Well, there's an upper Missouri Basin Compact. When they decided on how the storage was going to be distributed and all that, why they had an inter-agency, or inter-state really, agreement, a compact, on who was going to get the storage for irrigation, where it was going to go, especially on irrigation. Well, some of the states didn't benefit much from irrigation because the water was downstream from them, so they didn't get the benefits that some of the states farther on down the river got from the irrigation and power.

Of course, what happened with power, they can run the power back, like to the state of Montana, even though it's made down in South Dakota or in North Dakota, the power can be distributed back into Montana. So they get benefits from the project even though they're upstream from the actual flow of the water. But there are very complex agreements on how to do all these things.

[What] I was talking about was just the Corps of Engineers' management meeting, and it didn't try to change anything in the compacts or anything like that. It just says, "Well, here is how we're going to try to give everybody exactly what is in the compact." But sometimes if you don't--like I was pointing out before-- you can't actually do it exactly as you wanted to do it. So you try to figure out how you can do it, and still give everybody the best deal they can.

An interesting part of it is when you get into one of those tough years when there is a big flood or something like that, some of the Congressmen and Senators are very difficult to deal with. Back in the Corps days when I was involved in some of that stuff, we even had senators from North Dakota tell us, "You're only going to release so much from Garrison Dam and you're not going to fill the reservoir over so high." We'd say, "Now wait a minute, how can we do both?" Or, "We can do either one or the other but we can't do both."

Don't matter what you say or any other person, physical laws just don't allow us to do that. If you've got so much water that you cannot store it in a reservoir, it's got to go downstream. You can't just say we're going to put it in there and squeeze it together. But that's how stern they were and how uncompromising they were--because they had

constituents upstream and constituents downstream and they were telling both of them they were going to take care -of them. That was impossible to do. They really get angry at you because you tell them you couldn't do it.

Q: Politicians are not necessarily good about understanding some of these things, are they?

A: They understood them, they just didn't want to. They wanted to be able to tell their constituents, "We've taken care of your problem," and it's not always possible.

Q: In this particular kind of thing, where you would set out to adjudicate interests basically, what was the balance between rural and urban? Were there any significant conflicts in many of these areas between rural and urban interests, say irrigation versus flood control?

A: Well, you can think of a lot of incidences where rural people benefitted from storage that they didn't pay for. Just to give you an example, there was one small reservoir project in North Dakota that during drought years--it was a flood control project but it had some recreation storage in it--but during drought years they didn't have enough water downstream to water their cattle for some drought years. They had no rights to release water from there--there was no legal claim on the water in the reservoir.

The Corps or the Bureau of Reclamation, or one of the federal agencies like the Corps, would allow some release to go downstream to take care of those domestic needs, not [for] irrigation particularly but just to take care of domestic needs and to keep some fish in the stream and things like that, even though there haven't been any when the project was originally authorized. Nobody, of course, ever really complained about it. But they were getting benefits that they didn't pay for.

If they really wanted those benefits, why they should have been paying something for it. But they weren't willing to pay for the storage to put in the reservoir, but they were willing to collect the benefits from it. So there are a lot of people that want the projects to do things for them, but they don't want to pay for any of it.

I guess the biggest hassle when it comes to irrigation vs. flood control is the fact that you have to get somebody to pay for the irrigation. When it comes to flood control, if it's considered widespread benefits and therefore, unless it's for a particular individual or something like that, why the federal government generally takes over most of the cost, or it used to anyway. Things have changed somewhat. At least they took over the majority of the cost.

So it was a lot easier to get flood control projects than irrigation projects because you didn't have to go out and round up a bunch of irrigators like you have to get irrigators, irrigation districts, and so forth, to repay the costs of the irrigation storage. You don't have to do that with flood control. You just have to come up with a good B/C [benefit/cost] ratio.

So the Department of Interior, in their wisdom, decided that they would use some of their power revenues to help pay for irrigation. That was a big controversy in years gone by when some of the power revenues would be used to help pay for the cost of the irrigation. The way they did that, they had--oh what did they call them, they were area accounts or something like. In a particular part of the country, in all the Bureau of Reclamation projects in that particular area, the benefits from all of those would go into a common pool--or I mean the power, irrigation, and all those things would all go together--to help pay for the projects.

If there didn't happen to be as much irrigation benefits as the cost allocation indicated there should have been, that didn't really make much difference as long as they got enough benefits from all the other purposes, too. So it helped the irrigators get storage for a lot less then they probably would have had to pay otherwise. It helped develop the west, you know, doing that sort of thing.

Q: Oh yes, I guess they're finding out in California now the requirements for them to pay more for the water.

A: Well, then, of course, as time goes on, these water rights situations are really a tough thing out in the west because the western states allocate water and the appropriation, appropriative rights, were first in time you know and get the water. If you had an appropriated right dated way back when, nobody else could get the water you had. The way they used the water early on was kind of frightening too because if you had an appropriated right ...

The problem was people had a right to this water, and they could keep on taking it out of the stream all summer long or all during the irrigation season. Obviously, they weren't running it onto their irrigated lands all the time. It would just run on through their channels and systems on down the river.

But then, with a lot more coordination and cooperation, they got these people to shut down their gates when they weren't using it, so other people would have the water available, so it would stay in the stream. The next guy downstream would get his--who had second

right maybe-- would get his water. It wouldn't just be diverted off, all of the water wouldn't be diverted off--but if a guy was really hard-nosed, under the law he could leave his gate open all the time because he had that right to the water.

But they've been a lot more hard-nosed about it in modifying those laws and so forth to get more equal use of the water. They say that they can use it, and it has to have a beneficial use. But how do you enforce that? Are you sure that he's irrigating or isn't irrigating and all that? The irrigators would go out and shut down one guy's gate for water and open his. They had ditch riders, they called them, who were hired by the irrigation districts who had constantly, all during the irrigation season, go around from one irrigation gate to another to make sure that the proper gates were opened and that nobody had messed around with them because there's a lot of people trying to steal water.

If they were down the list in appropriated rights when they weren't getting any water and other people were, why they would try to go and steal from someone. People would shoot each other and everything else out there when it came to water.

Q: Matters of livelihood are the key. Up in the upper Missouri, did you have a lot of difficulty with water rights?

A: Well, there are state documents listing water rights. Wherever there are appropriated water rights, you have a lot of problems with it, the state does, trying to maintain it. Another thing, when it comes to the water rights that are given for people in a rural area for irrigation, what happens when a community needs water. How do they get it. They go out and buy some of this land that has a water right and then they convert the water to M&I [municipal and industrial] use instead of irrigation use.

So the use of the water gets turned around. A lot of that has happened. A community, for example, could buy land that had an appropriated water right, take that right and use it for M&I, and then sell the land for somebody to do dry farming or development or some other purposes.

Q: But the states were really the ones that control those things, aren't they?

A: The Bureau of Reclamation does handle water rights, too. The Corps of Engineers never gets involved in water rights, never, it was their policy--that's a state problem. But in a lot of the Bureau projects in connection with the irrigation, they actually got a right one way or another, I don't know, it depended on whether there was any rights left or not.

But they actually got rights and sold water. They sold water to people based on their right to the water, and then they would sell it to the various customers.

But the Corps never felt that they owned any of the water. Well, the Bureau didn't either except that they owned the right to it. Once they got an appropriated right, they'd store it in their project and they could sell it to other people like the irrigators and so forth. So it was a little different deal with the Bureau than with the Corps.

The Corps didn't worry about whether it had a right to store the water or not. As long as it was causing a flood! the laws allowed them to store it and reduce the floods. But, anyway, it's a complex subject, I guess, and kind of hard to explain all the weird things that go on.

Q: Well, it certainly is one that is becoming more obvious, especially in a place like California. I guess in places where you have the old Spanish water rights and people have those rights that pre-date the states.

A: Well, the lawyers are fighting all about whether those rights are any good or not and it's like they take away things from the Indians, probably taking away some of these Spanish rights that they had too, a long time ago. It's what is fair, and some places it's a lot fairer than others, I guess.

Q: I think it's something they call situational ethics. You were up in the upper Missouri basin at the time that a lot of the work on the Pick-Sloan Plan was under way. The big main stem dams, starting with the Garrison Dam, at Gavins Point, Fort Randall and all these other ones. How much do you think that has changed that whole area from what you knew when you were growing up there?

A: Well, the biggest thing that I can obviously see is the change in availability of electricity. The REA [Rural Electrification Administration] handling of the electricity, using electricity from all these big projects, to modernize farming. Most of the farmers had [had] their own little power plants. Years ago when I was a kid anybody that had electricity on a farm, they had their own little generators and made their own power. They didn't have any power lines coming out to their house so that they could use electric power for all kinds of things that they do now.

My brother-in-law is a farmer out there, and he uses a tremendous amount of electricity for drying his grain, for all kinds of different things. He has all kinds of electrical equipment that he uses in his farming operation. He wouldn't be able to do that if it

hadn't been for this availability of electricity. So there's a lot of power--power has changed the way the farming **community** lives and operates.

Actually, as far as the irrigation, I don't really see too much of the irrigation part of it where I happen to live. Just that they hadn't received really much irrigation. There are a lot of irrigated farms now, of course, because of the Pick-Sloan Plan. But there has been a big reduction, of course, in floods. That is one of the major contributions is the cutting back on all the flooded areas.

There are still areas up there that are not protected by these large dams, too, like the Red River of the North. There is still a lot of flooding that goes on up there because they don't have any major place to store the water and the land is so flat it just floods everything.

Water Quality

Q: Wasn't that an international problem because you had to deal with Canada on that river?

A: Oh yes, it's a serious problem there--well, one of the things is the water quality, that's a big problem, with irrigation return flows picking up a lot of saline material and other contaminants coming into river. They go into the Red River and the Red River flows north up into Canada with all of these contaminants in it and Canadians scream in horror, "Hey, you're messing up our waterway." They have a lot of problems with trying to take care of that sort of thing.

Q: That's a problem in the big dams up there, too, isn't it. The contaminants come into the pools and settle.

A: Actually, it's not such a big problem with a big dam--the contaminants usually take place when you're getting return water that has gone onto a field and it leaches the salts out of the soil and so forth. They dissolve in the water and then they come back into the return flow channels that take that return flow back to the river and the water that goes back in the river is not anywhere as near as good as the water that came out of it to begin with.

Now they have things in reservoirs to help them avoid that that they didn't have earlier. But they have more of them now. These multi-level withdrawal outlet type things where they can take the water out of the reservoir at different levels. Now the water is the worst at the bottom of the reservoir. That's where a lot of the vegetation decayed and there's a lot of different kinds of chemicals and things that develop down there that are

undesirable.

So what happens is if you build this outlet works that can take water off the middle of the reservoir or near the top of the reservoir, you get a lot more oxygen in it. The big part is the oxygen depletion. What happens if you draw off the bottom of the reservoir [is] you don't have hardly any oxygen in the water and the fish can't survive downstream. If they swim up the river and they get close to a project that is dumping this oxygen-deficient water, then they of course die or go on back downstream. They just can't get up close to the project.

Well, they've come up with different devices to help that situation. They put in mixing gadgets to stir up the water so that they don't get all this stratification of water, you know, the good water on the top. Then, when the temperatures change, the water turns over and what happens is the water on top gets colder and heavier and the whole thing turns over.

You'll find that sometimes in the water supply here it'll have a bad taste to it probably for a little while when the reservoir turns over until it kind of settles out again. That's when all this bad and good water will mix up.

Q: Were these kind of things with reservoirs fully known when you were working up there or is that a result of the hydrologic studies that have been done since?

A: Well, when I first started in the business we didn't even know much about stratification of the reservoirs. We knew a little about it but hadn't had any money to study that sort of thing much. So it wasn't until after they started learning more and more about how water quality is important. As a matter of fact, there used to be some strong arguments.

I remember one time, well after the Clean Water Acts. When you go back to when they first started, let's see, the Water Pollution Control Administration [WPCA] was the first agency I think that handled that sort of thing. They were trying to make other agencies be responsible for water quality and take a real active role in trying to clean up the quality and that sort of thing.

One of the things that the Corps used to have is storage in the reservoir for mitigating water quality damages by discharging flow out of the reservoir. They'd use storage in the reservoir to dilute the contaminated water downstream, and they claimed the benefit for it. Well, they finally decided they [the Corps] couldn't get credit for that kind of a benefit anymore. They said they'd [the Corps] have to clean the water some other way, not use dilution as a solution. One of the arguments, no more dilution as a solution.

I remember even having a big discussion at one of our conferences out in the Pacific Northwest one time. My boss at that time was Al Cochran. He was head of hydrology for many years in OCE [Office, Chief of Engineers] and taught me a lot of the things that I learned and knew about hydrology. But he was real slow to take up this concept of water quality. He didn't really want to get into it. He just seemed like he was very slow to grab on to it.

But, anyway, we were having a big conference up there on a reservoir, and I was concerned about some water quality studies they were doing there. I was telling them, "Well, even though you're contracting out these water quality studies to some experts that are not in the Corps of Engineers, you need to get these computer models, you need to be familiar with them, so you can use them in your reservoir regulation procedures because you are the guys that are responsible for that water quality. So if you don't do a good job on it, why the Corps is going to get a bad name, and you've got to work that into your water quality management."

My boss was sitting there listening to me. He said, "No, no, don't worry about that." I kind of was taken back quite a bit by his attitude on it. The conference went on and on. All of a sudden right in the middle of some other discussion, Al booms out, "Wait a minute." He said, "By god, you do have to do what Hagen said." He says, "I'm wrong, you do have to be responsible for that water quality." It really surprised me that he did that. But he got to thinking about it, and he says, "Hey, we do have to do that." So he made his opinion clear then that we were going to have to be responsible for it.

But it was tough getting people to take on the responsibility of improving the water quality. Actually it was kind of a thankless job. There was not much money for doing it. It was a tough, difficult thing to do. Hard to figure out what to do.

Q: So the hydrologists would have been some of the first people in the Corps' to have greater sensitivity to environmental issues dealing with water?

A: One of the things we found out, too, was in training people to deal with reservoir water quality--now reservoir water quality is the primary thing that we're talking about here. But yet we found that it was easier to take somebody who was a trained hydrology person, we'd like to call them. Practically all the people we had in those days were engineers, not hydrologists per se. A hydrologist doesn't have to have an engineering degree--it can be a degree in science and not engineering.

We usually had engineers as our hydrology people whereas not necessarily the Soil

Conservation Service [SCS] but the USGS [U.S. Geological Survey] would hire hydrologists to work on the scientific aspects of hydrology. We found that it was easier to train somebody who was an expert in hydrology in the water quality aspects than it was to bring in biologists and people who were trained in the water quality of the chemical and biological parts of water quality [and] to teach them the hydrology they needed to know to go with managing the reservoir.

So a lot of the people that were managing the water quality sections or branches in the Corps offices were really first trained in hydrology, although we did bring in a lot of biologists, chemists, and other people, too. But it seemed like they weren't as well equipped to handle the management part of it. They were pretty good on the technical aspects, but they didn't really know how to handle the operational part of it as well. So it usually turned out that the people that were trained in hydrology ended up being in charge of water quality, too.

Q: Now that whole thing was quite a change for the Corps wasn't it?

A: Oh. yes it was. It was a really dramatic change. They were really slow picking up on it and when they finally got going on it, they did a good job. It just took them a while to get going. They were just reluctant to take on the whole concept. You would hear how the Chief of Engineers would get up before the division engineers and tell them, "Yes, we're really going after this water quality and the environmental concerns." But for the action to get down to the working level sometimes it was pretty hard to convince those working level people that they needed to do things like that.

It was typical of a lot of different Corps programs. For example, the Dam Safety Program of non-Federal dams that the Corps got involved in. The President said, "The Corps will go out and examine all these non-Federal dams for safety." But there was a limited amount of money to go with it, the authority to do this and the responsibility to do it.

A lot of the practicing engineers in the Corps were very reluctant to get involved because they knew they weren't going to be able to spend enough money to really find out for sure whether those dams were safe or not. Especially the structural engineers and the soils engineers, too. How do you know what kind of condition that dam is in if you don't go out and do a lot of testing and soil drilling and things like that to find out if there is leakage internally in the project or something.

They hadn't had any experience on these projects. They were going off and taking a quick look at them and deciding whether they were safe or not. So it ended up that the Chief of Engineers had all the people in the office one day and he told them, "Hey, we've got

this program. The President has told us we're going to do it and I'm telling you I'm working for the President." He said, "I'm going to do it, and you're working for me, you're going to do it." It's either do the job or find some other job.

Q: Was that Chief Jack Morris?

A: Well, was it Jack? I don't remember, it might have been Jack. Might have been him.

Q: That sounds like something he'd say.

A: But anyway, it probably was him. Can't remember for sure. But anyway, whoever it was at the time, he really came down hard on the field offices and said, "By god, let's not hear any more of this moaning and groaning and stuff like that. Let's get with the program." So it finally got going. But, there were still a lot of people out there that weren't willing to make any kind of commitments.

We finally got to the point where we didn't really say that any of them were safe. We just wouldn't say they were safe. They were just kind of a no case. If it wasn't unsafe, we didn't say much about them. If we found things that were unsafe, why we would report them. Otherwise we just gave them an informational package on what the dam was all about and what it did and not say anything regarding safety.

Al Cochran and Gail Hathaway

Q: Several minutes ago you talked about Al Cochran and what he meant to you. Wasn't he was one of the first people to get hydrology accepted at OCE?

A: He wasn't the father of hydrology. Gail Hathaway was the father. Al was the guy that went out and sold a lot of it after Gail had first got it going good. But he worked for Gail. He and Frank Snyder were the two of Gail's disciples I guess--hydrology disciples or whatever you call them. They were the ones that really sold the program to the Corps and to everybody else. But Gail was the one that started it off. I never worked for him but I knew the man.

When I went to OCE, Al was in charge and Gail was working for the chief as a special assistant. But Gail really had a lot of respect from all the people all over the world for his ability. Well, he was head of the ASCE [American Society of Civil Engineers] one year

and, he went over and made some talks on high dams and stuff like that.

Q: Yes, he was a leading person certainly in the Corps and the whole area of civil engineering.

A: I guess from my own personal experience, why Frank Snyder and Al were the two most important people in my career as far as training me and giving me the ideas that I have and so forth. Frank was particularly important in my career because when I was first in OCE, whenever I had a question I could go and ask him a question on almost anything and he knew the answer to it. It didn't make any difference what it was. If he didn't know the answer, he'd figure it out and get you an answer in a couple of minutes.

Probably from a purely technical standpoint, he was better than Al. But Al was a very domineering type fellow who could get things done by going out there and beating on the table and arguing. Well, he was knowledgeable, too, but I don't think he quite had the technical wherewithal that Frank had. But Frank got a lot of recognition for his capabilities all over the world.

Well, you know Gail and Al and Frank are all in the distinguished gallery up there in OCE and Jake [Douma] , too. So they were recognized for their capabilities all right.

Fort Peck District, 1953

Q: When you left the BuRec and went to Garrison District, was that just a promotion or did you want to change what you were doing?

A: Well, I wanted to change what I was doing. What happened was I was working in the district office there, and they had a RIF [reduction-in-force]. As I was telling you, these were tough times. They shut down that office pretty much--I mean to a non-engineering office, it was more of an operating office. They moved me over--because I was a veteran I was able to maintain the same grade--but they moved me over into a land acquisition unit.

Well, I didn't stay there too long before I got this job at Fort Peck. I didn't like that kind of work and I wanted to get back into hydrology and hydraulics and a job came open in Fort Peck and so I applied for that. So I went to Fort Peck.

Q: What did you do at Fort Peck when you went there in about 1952?

A: '53.

Q: So you went to Fort Peck Dam or was it Fort Peck District, was that still in existence?

A: There was a Fort Peck District at that time. When I was there they shut down the district, and it no longer became a district. They moved most of us over to Garrison and a few of the people they maintained there for operations purposes.

At that time, of course, Fort Peck was completed and we were a Fort Peck District but we weren't really working on Fort Peck other than operating it. The projects that we worked on were other places and were levees and small dams. We did some work on Garrison, too. But there was a Garrison District, too, at the same time, and so we didn't really do much work on Garrison. A lot of the work on Garrison had already been done.

Q: It was in the middle of construction then, wasn't it?

A: It was in construction. So all the design work and that sort of thing had been done.

Q: Well, Fort Peck has a monumental place in the Corps history for a lot of reasons. One of them being it's famous slide in the late 1930s.

A: Oh yes.

Q: It's a huge project, isn't it?

A: Yes, it's a big project, but when I was there, there wasn't a big staff there because it had all been completed and it was really just kind of an operational district, even at that time. There were not very many studies being conducted from that area. There were a few but not very many. Gordon Lightfoot was the chief of engineering at that time there. He left there. He came to Washington to work with AID [Agency for International Development] program, I think.

Q: A-I-D?

A: Yes. But he was a real top notch engineer, Gordon Lightfoot. He was one of the better

engineers that I've seen in charge. I had some good chiefs of engineering along the way, too. Some really good ones.

Q: When you were in positions like those at Fort Peck, did you have much to do with the people from Missouri River Division?

A: Well, they were, of course, our supervisors in a way. Not day-to-day supervisors, but they had to review everything we did. Once in a while, they would come out there and go over the studies we were doing and tell us whether they thought we were going in the right direction and that sort of thing. McLendon used to come out there once in a while and give us direction.

At Fort Peck, well, I really didn't get as much at Fort Peck as I did at Garrison. I had more dealings with the division at Garrison then we did in Fort Peck. But in Fort Peck--well, I was only there for about a year. I worked in the Hydrology Department there and a good share of my time was spent on the Sun River Project, a levee project up in Great Falls which was an interesting project from a standpoint that the engineering work I did on that I use to help get my professional registration at that time in Montana.

You had to submit evidence of actual engineering work on a particular project of some sort in order to get registered. You don't have to do that anymore. But in those days that was part of the requirement. So I used the studies I had done on Sun River to help get registered.

Q: That sounds like a healthy idea, actually, doesn't it?

A: Well, it is one, but they just don't require that anymore. It was more tough really, I think, at that time to get registered in Montana than it is now because of the fact that you may not have had very many significant design jobs in the first four years you work because you may be working as an underling for somebody else on most everything and not have something you can point to and say, "Hey this is my original work, and I was the guy that was responsible for getting this completed and so forth."

Fortunately I was able to do that on this Great Falls project. The interesting part of it was that we were designing this--well, most of the time we tried to design levees to take care of the standard project flood. I don't know if you're familiar with various types of floods and so forth, but they are a pretty good size flood normally.

At Great Falls the Bureau of Reclamation had made some proposals to protect Great Falls

from the Sun River by headwater dams, you know adding to their Gibson Darn way up in the mountains and so forth. Of course, we in the Corps argued that they were only controlling a small part of the drainage area and that wouldn't do very much for flood control.

But history made it look good for the Bureau because the major floods had happened up in the mountains. They hadn't really had a major storm over this big drainage basin between Gibson Dam and Great Falls. Maximum flow at Great Falls at the time I was working at it was about 17,000 cfs [cubic feet per second]. I worked on the standard project flood with some guidance from McLendon on the rainfall.

I worked up that standard project flood. I come up with a value of like 60,000 cfs, or something like that. So much more than they had ever had there that I thought, "Boy, I'm going to have a heck of a time selling this to anybody that would be willing to design for that big of a flood because traditionally if you had something that is quite a bit bigger than the people had seen before, you have a hard time selling it."

But my boss has accepted everything that I had done, and McLendon accepted it [and it] went right on through and got approved. They didn't build at that time, but many years later the Omaha District was handling that project up there and they had a big storm in '62, I think, or something like that, and it almost reached the standard project flood that I had computed back in those days. Just to show that just because you haven't had some doesn't mean you're not going to get it. The big thing about hydrology is trying to convince people that a potential for floods is there in a lot of cases, even though you haven't experienced it.

The Theory of Hydrology

Q: A lot of what the hydrologist does is basically theoretical then.

A: Oh yes.

Q: It's hard to sell people on theory, isn't it?

A: Oh, very difficult. Well, you take this big drainage area like we had, a pretty big drainage area above Great Falls there. We knew there was a lot of potential for storms up in that area. We knew where storms had occurred all around it, and we knew the size of those

storms. How much rain had occurred in the time, the distribution of the rain, and so forth. If you move one of those storms over the basin, you can see that the potential is great there.

But because that storm hasn't actually happened over their basin, they're very difficult to convince. But you can show them on paper pretty easily. "Hey look [at] it. All you've got to do is move this storm over here a little bit and here is what is going to happen." But they say, "Oh well, I've lived here for 50 years and I've never seen anything like that. So you must be really imagining things." So it's a tough job trying to sell people on the risk they face in flooding if they haven't experienced it.

Q: So in hydrology you use an awful lot of meteorological data?

A: Oh yes.

Q: There is a lot of that in your computations.

A: One of the things that the Corps did early on, back in Gail Hathaway's days, was to fund a big contingent of the National Weather Service to do studies for the Corps. Practically everything they did was in connection with some Corps project because the Corps was paying all their salary. To this day, they still pay for a good portion of those people's salaries.

While they don't dictate exactly what they do or how they do it they just dictate that they have to work on Corps projects and do the work for the Corps. One of the reasons [was] that Gail felt very strong about having a component outside of the Corps who really had no interest in pushing a project or not pushing a project. Where they're completely unbiased, you might say, in doing a meteorological study.

Whereas, if you are a member of the Corps of Engineers then you may be influenced in your studies by your boss who wants to have a low answer or a high answer or whatever he wants to have. He may put a lot of pressure on you and even though you may not think that you're complying with that pressure you may just say, "Well, I'm really going to try to get the smallest answer I could to keep peace in the family," or something like that.

I've run into situations like that, too, when we were in Garrison we had a chief of engineering who didn't like the answer for a standard project flood that he got out of hydrology because there was so much political pressure on reducing costs in this one project. He told my boss at that time to go back and redo his studies because he had made

a mistake and it was too high.

Well, there was another example of where shortly after the study had been done they had a big flood and a big flow very close to what the standard project flood had been estimated to be. So Dick Fields said, "Hey, I guess you're right, go back and change it." But if that flood hadn't come along, why his trying to satisfy the political concerns would have had a big impact on the design of the project. It's tough.

The funds are limited and everything--what do you do? Do you still do all of your hydrology on the basis of no concern about what it cost to take care of it or do you try to squeeze it as much as you can to make the hydrology fit the project that the people want and that sort of thing. There is a lot of politics involved. Of course, most of the people that I've dealt with in hydrology were on a high professional level [and] felt very strong about being unbiased about their decisions and try to keep answers reasonable and not actually fudge the answers to get something that a top official might want.

Q: That's in the area of ethics that has become much more important now for professional engineers.

A: It's an important one of engineering--you know it's tougher in an area like hydrology than in something like structural engineering where a lot of the stuff is pretty straight forward. It's all well documented and everybody knows what the right things you're suppose to put in there and so they can't ask you to fudge any.

But when it comes to hydrology, suppose the project doesn't quite make the benefit/cost ratio and there is a lot of pressure to have that project have a B/C ratio of 1.0. The planner comes over to you and says, "Hey, we can't make it on this project and the Congressman wants it real bad. The district engineer called and we're going to build him a project. What can you do with that frequency curve?"

Well, all you got to do is move the line a little bit and the project is justified, you know. It doesn't take much to move that line. But we'd say, "Well, grant it, it's possible that it could be on that line but how about your damage analysis. You know, how good are they? Are they so accurate that you couldn't change them to get your justified project ..." "Well, no they're accurate." Well, they're no more accurate then the frequency curve. Now do you fudge it a little bit until you get the project?

You know for certain that the answer you've got isn't proof perfect, you can't prove that it's perfect, but you still have a tough time trying to say, "Well, should that thing be

changed at all or not." Some people, if you give them enough pressure, might change it a little bit. Others--they wouldn't change it no matter what. They say, "This is my best answer and I'm not going to mess with it at all."

But you have to realize, I think, in some areas in hydrology that there is enough margin there that if you just made it a little bit of a change that you're really not going to hurt anything. You're not going to be misrepresenting the facts or anything like that and to be so hard-nosed that you could never move that line one way or the other because you don't have any way of proving it. Your answer is absolute. If it's for the good of the country or something, maybe you can move it over.

Q: When you get into that kind of theoretical area, though, that's a problem, isn't it?

A: It's a real difficult problem. How much can you move it though. If somebody says, "Move it a long ways." Oh hell no, I'd never do that, that's obviously wrong. But when you're right on the verge, right in the middle there where a decision to go one way or the other could make or break a project, what are you going to do. You're going to get a lot of pressure and a lot of times the people will say, "Well, there are other benefits that make up for that anyway so why worry about it." That's a part of it.

Al Cochran use to be very adamant about trying to get as much out of a project, in terms of degree of protection, as he could. He really pushed for that; most storage you could get or the highest level of protection in a levee. He'd try to squeeze every bit he could out of it because he always felt that we hadn't experienced enough of the floods yet. There were a lot of them coming that we hadn't seen yet and that it was--well, there were a lot of things that go into the philosophy behind that.

For example, if you build a reservoir, you take a valuable dam site. There are not very many of them, hardly any of them left anymore. But back in those days, when they were building a lot of dams, you've got only one dam site there. If you would optimize the economics of the project and just only put enough storage in there to get a B/C ratio of 1 .O, then what happens is you're really not taking full advantage of the site there.

They may have gotten a lot of room to put in more storage in there that could be used maybe later on, but you're just not sure of what all those future uses might be. While they put in future water supply storage in a lot of projects on the bases that the state would say they needed it in the future. They would put that sort of thing in.

But Al felt that, "Hey, if you spent all the money to build this project, why not put a little more storage in to give you a cushion to be sure." There were a lot of projects where his

concept saved a lot of people's lives probably and a lot of money. The Cherry Creek Dam in Denver is one of them where they got a huge flood after the project had been built for a while.

There were enough benefits from that one flood to more than pay for the project, not to have to worry about any other floods paying for it. So the economics, even though it looks good on paper, why you can't really be sure. Even though what has happened in the past is a pretty good indication of what might happen in the future, we have such a short time span for looking at the past compared to what the future is going to be that we don't have that good of a fix on what is going to happen in the future.

Besides that, when you're looking in terms of hydrology, probability analysis--if you had thousands and thousands of years of record you could get a real good indication of what the probability of flooding was going to be in the future. But that doesn't necessarily mean the probability of flooding in the next 30 years. It may be real good for an infinite period. But for the next 30 years or the next 50 years that you're really concerned about in your life span, that probability may not be right at all. The next 30 years may be wet years, they may be dry years.

So, even though you have the best possible analysis of what the probability conditions might be in the future, is that right for the next 30 years. Is that right for the next hundred years? You say it is, you know in a lot of cases on the average it will be, but it's not going to be for a particular project or a particular area, it is probably not going to be right. Like having one foot hot and one foot cold, but on the average you're comfortable.

Q: So in your side of the business, you really have to be more conservative.

A: Well, we feel, or most of us, feel that you should be conservative because to error on the low side or I mean to error on the one side, the consequences are more severe than they are in the other direction.

Dam Safety and the Big Flood

Q: Do you want to continue your comments on the conservative nature of hydrologists?

A: Well, of course, I guess one of the biggest areas where conservatism comes into the picture is in dam safety and the probable maximum flood. Are you familiar with the probable maximum flood, have you heard about that?

Q: I have, but very sketchily.

A: Well, in the case of the probable maximum flood--early on back in my early days they would design spillways and top of dam, with a combination of top of dam and the spillway, so that it could pass very big floods based on statistics, which we had short records and we don't know how to estimate rare frequencies because we don't have a long enough record, of course. Still don't and probably never will have a long enough record to do a good job on statistics.

But people were estimating lO,OOO-year floods and saying, "Well, this lO,OOO-year flood--we'll design our spillway to pass that 10,000-year flood." When, in fact, the curve that describes probability can flop in either direction quite a ways.

So the Corps was looking for standards. Some sort of a standard that they could use to judge one project against another. Since they knew they couldn't do very good with statistics, in trying to come up with good information on statistics, they were looking for some other parameters to form a performance standard, so to speak. So they could say, "This project is built to the same standard as some other one."

So that is when they got really interested in working with the Weather Service on our flood potentials--you know, what is the potential, what is the most extreme flood you could get here? The Weather Service says, "Well, we can give you some rough estimates on over that particular drainage basin, what the biggest storm might be." You can figure the hydrology that goes along with it.

But we haven't studied the stuff enough to really know for sure. We need to have a lot of data, and we need to do a lot of studying in order to do this sort of thing. So the Corps says, "Well, why don't we work together." The Corps will go out and get information on all the biggest storms that have happened all over the country. They'll spend the money to go out and get the data on those storms. "And we'll feed all this data to you and you can use that data and your expertise in meteorology to come up with the biggest storms that you can get anywhere in the country." That was the philosophy. So the Weather Service says, "Sounds good, do it. We're willing to do that."

So they had a storm study program. The Bureau of Reclamation got involved in it, too, and so did the Soil Conservation Service. They would go out in the field, and they'd get all the information they could on historical storms. The storm occurred say in 1908. They'd get all the data that had been taken. They'd go out andinterview people who happened to live in that area at the time of the storm and find out if they had any historical notes or anything that could tell them how much it rained and how long it took for that

rain to take place and all that kind of stuff.

So they got all kinds of good data from the storm study program. There were a lot of storms studied, and the rain distribution intensity and all that stuff was developed for all the storms. The Weather Service used that, then, as a base for working on maximum probable floods--at the time they called them maximum possible storm. They finally changed the name to probable maximum because they wanted to get across the idea that it wasn't necessarily absolute you could get it but something that was reasonably possible. So they called it probable maximum. The Weather Service worked up generalized procedures for coming up with that rainfall.

Well, here is another area of difference between the Corps and the Bureau. The Bureau was having a tough time supporting the cost of their projects. Doing something like this and coming up with extreme storms to design their spillways for them or something like that, it's going to make their projects a lot more costly.

So they weren't so sure they wanted to just go into this with everybody else and let the Weather Service make all the decisions on the storm. So they did their own analysis of storms out in their area. They said, "We'll do our own storm analysis and decide what the probable maximum flood should be out here." The Weather Service has ever since then been doing the probable maximum storms for the Corps. Then the Corps takes that probable maximum storm and turns it into a probable maximum flood which in turn is then used to design major dams. The whole concept of that has been questioned by people since then but this is just what happened early on.

So what happened is that the Corps and the Bureau were working in the same area and were getting much difference in their probable maximum floods. The Bureau's were much smaller than the Corps'. Primarily motivated, I'm sure, by cost. They didn't want to spend the extra money for the big spillways, so they argued that they would use all of the logic that they could come up with to say that the storms couldn't be that big.

Whereas the Weather Service, they didn't care one way or the other what the cost was. They just said, "Well, based on our experience and knowledge about storms, we could move them around and the storm that happens here can happen over there and so forth." They would maximize the storm. They moved the biggest storm in the area over to this other location and then they would decide what this transposition did to the storm. Would it make it rain more or less and so forth, depending on the elevation and all or the geography of the area and all that kind of stuff. They have published a lot of documents on how you do this sort of thing.

But anyway, there was so much political heat about the difference between these probable maximum floods between the Corps and the Bureau of Reclamation that I think it was the Assistant Secretary of the Army for Civil Works got together with the Secretary of the Interior at some party somewhere and they got talking about their differences. They said, "Well, we need to get together and have the top hydrology people in the Corps and the Bureau get their heads together and come up with a same procedure for doing this. We want to find out why there is such a big difference and we want to get that difference solved."

The Chief of Engineers told me, "You are going to be my representative for the Corps to get this thing straightened out." The Bureau of Reclamation also had a representative that had been named, and we had some meetings. We found out right away that the techniques we used for transferring the storm into hydrographs were pretty much the same--that you couldn't get much different answers if we both started off with the same rainfall, our answers would come up pretty close to the same hydrograph.

So we realized right away that the big problem was in the probable maximum storm, not the hydrograph, but in the storm. Since the Weather Service was doing it for us and the Bureau of Reclamation was doing their own, the controversy was between those two agencies not between the Corps and the Bureau.

We had to get the Weather Service and the Bureau of Reclamation working together trying to see how we could resolve this thing. We finally set up a committee of several agencies and how we were going to do this inter-agency thing.

We agreed on all the stuff east of the 105th [Parallel], primarily because the Bureau didn't operate east of the 105th. So they agreed that we would all use the Weather Service's stuff east of that area. But west of that, where the Bureau operated, there were going to be some more problems about how we went on doing that.

Well, about that time the guy who was in charge of storm studies for the Bureau retired. They started looking for new staff, and they hired somebody from the National Weather Service to do the meteorology studies who had been trained in doing it the way the National Weather Service did it. Not only that, but they were also looking for a new chief of hydrology. It turned out the guy that got that job had been working in the office in San Francisco for the Corps and in Albuquerque, and he wanted to get back to the Denver area where he was from. He got the job as the chief of hydrology for them.

Both of those guys were trained in doing things the same way the Corps did. So they started influencing what was happening in the Bureau of Reclamation, even though they had some tough sledding they turned the Bureau around as far as the probable maximum

floods were concerned. Dealing with some of their bosses, we had some conferences and there was a lot of controversy and so forth. You're always going to have continuing controversy on that subject.

But the Bureau has really turned around on probable maximum flood. It has gotten them quite a bit of work because they can build up their projects-do redesign on some of their projects. They went into Congress with a Dam Safety Bill, and they said, "Hey, we've got all these projects that need to be upgraded, and it's up to you to give us the money to do it."

Well, the Corps didn't do that. They took a different approach in trying to upgrade their projects. They were all presumably designed for the probable maximum flood, but through the years, changes have taken place and some of those probable maximum storms were actually bigger than they had been when they were originally derived. So the Corps had some dams that weren't up to the top standard either anymore.

Then we got into the Gianelli [William Gianelli, Assistant Secretary of the Army for Civil Works, 1981-1984] era where he didn't want to spend any money on dams or dam safety or anything of that nature because the administration didn't want to spend it. He was very strong in not spending any money and dam safety was one of the things he wasn't too interested in. We had a hard time selling dam safety to him because as far as he was concerned anything that had such a rare probability of happening, why he didn't want to waste the government's money on it.

While he wanted to give a little token support for dam safety, he really didn't want to spend a lot of money on it. We didn't get very far with him on the Dam Safety Program while he was there. Since there were people promoting this concept of using risk analysis in designing the safety of dams and there are a lot of highly competent people that were promoting risk analysis when they designed dams.

Of course, that brings the economics into the picture and it brings probability of floods into the picture, rare floods, real rare floods, which all the statisticians say you can't do. But still people would come up and say they could do it. It means things like evaluating the loss of life. If you've got a big dam, like these Missouri River Dams, and they fail, a lot of people are going to drown likely. What is their life worth? All that kind of stuff really has to be cranked into the studies if you're going to do a real thorough risk analysis study.

There were quite a few years where there were all kinds of meetings going on. All kinds of conferences promoted on dam safety. Then the Federal Emergency Management

Agency [FEMA] was formed, and they got the responsibility for any major disasters in the country. They were supposed to be the leader on what the Federal Government did in the area of dam safety and other hazards.

But they didn't really have a lot of expertise on how to do it, they just kind of tried to organize everybody else They were the chairman of the committee, but they didn't necessarily have the best expertise on it, they just tried to get the other agencies together and so forth. They had a lot of private people working on it. Stanford University worked on it, MIT worked on it, and we had some real firm debates out in Stanford and up at MIT on what you should do in dam safety.

A lot of these people that were promoting real strong for risk analysis, one of them in particular, he was one of the most ardent proponent--or had the strongest argument about using risk analysis and probabilities. I would argue with him about, "Hey, you can't compute probabilities that accurate." He was a real expert on statistics. He'd say, "Ah yeah, we can do just as good on that as you can on the rainfall for the probable maximum flood."

But after they published one of the books on those committees from the National Academy of Science, he wrote a chapter in the document on risk analysis. He went back to his home university, and he actually took on a review of some dams up in that area in New England to see how he could design those for risk analysis. He ended up finding out that he really couldn't do it. He couldn't get the answers to come up good enough. There was so much variability in his probability analysis that he couldn't get a good answer, a good definitive answer in risk analysis. He even stated so in another publication after that.

But there are so many theoretical people from the university who think things should work by theory until they actually get out in practice. There has been a lot of that happening. Professors beat the drums and write papers and give speeches and stuff on how to do things and then when they actually have to go out and prove their technique in a practical way, they can't do it. But they get everybody allexcited about it, you know, in doing it that way.

The Gap between the Scientific and Practicing Engineer

Q: Is the value of your advisory committees, bringing in these people to see some realities and the value of an organization like ASCE, bringing your academic colleagues in with the practitioners who have to do these things on a day-to-day basis?

A: **Now** there is a gap between the scientific and the practicing engineer, and it's a tough gap to fill because you don't have very many people who know enough about theory. Practicing engineers--most of them don't have the time to spend at all on the calculus and things that goes into some of these theoretical applications to really understand how you apply them.

The scientists, they come up with these theoretical ways of doing things, but they don't have the time to find out whether they can get the data that goes into their procedures or their formula and their models and so forth. So they just go on saying, "Well, it must work, theoretically it's sound."

That was one of the reasons that the Hydrologic Engineering Center [HEC] was established out in Davis [California]. It was to try to get people out there who had enough smarts about the scientific side of the house and yet apply these things in the practical sense, try to apply scientific theory to practical problems and see if they couldn't bridge this gap and get more of these theory--more of the scientific theory into the hydrology then had been in the past. But only if it was going to be useful, not just because it would look good. They've done a pretty good job on that.

Of course, that is nearly impossible to do. But they've done a fairly good job whenever they try to apply some of that scientific stuff, which they have gotten from different professors. They're located in Davis, California, right next to the University of California in Davis. They interact a lot with the professors there. At night you see HEC people who teach courses over at the university so there is a lot of interplay there.

But it has always been a tough problem with this communication gap between the scientist and the practitioners. Well, ASCE, I think, is the best organization for trying to bring the two together. AGU [American Geophysical Union] is not as good an organization for this purpose because it is primarily scientifically oriented. Most of the people who belong to that organization are professors and scientists of one type or another whereas the ASCE has more of the practicing engineers and they have a lot of professors, too, in ACSE.

So they get together more and they get a better chance to understand each others point of view. Whereas in AGU you've got one scientist talking to another scientist. Neither one of them have had any practical experience maybe in what they're talking about.

I think of my experience when I was taking graduate courses at Catholic University. I got a Master's degree there by going to school at night for five years. One of my professors was a guy by the name of Ken Young, who has an engineering firm here in Springfield now. He was relatively fresh out of school and had his doctor's degree and all these fancy

things like dynamic programming and linear programming, water resource studies, and that sort of thing.

He had a lot of good theoretical stuff and was a real good professor as far as knowing all the theory and things that go into it. He was working for the Federal Water Pollution Control Administration at the time, and they had some kind of backward methods for doing hydrology. He would come to class and tell us about how his agency was doing things wrong, and he assumed all the agencies were doing them wrong, too, because his agency was.

He would tell us about, "Well, here is the way it should be done but it's not being done that way in my agency." I'd say, "It hasn't been done that way in the Corps for years." So it is your agency that is backward not the whole government. Anyway, he was going to bring everybody up to speed on how to manage reservoirs with dynamic programming.

He was going to use dynamic programming because he had written some articles on how to do it. But in order to do it you had to have loss functions. You had to know that certain losses would take place if you didn't have enough storage or if you didn't get the proper releases downstream for all these various purposes such as water quality, main&ream fishery, and all those good things. About the only things you could tie down the loss functions on were hydropower and flood control.

You couldn't tie them down very good on water supply because you don't really know what the benefits of water supply are other than the fact that if people are willing to pay the price for it, it must be worth it. So that doesn't really give you or tell you much about the benefits of it. All it tells you is that they were willing to pay that price for it.

But then I would say to him, "Well, Ken, you know you're teaching us this stuff about dynamic programming, and we have loss curves." I said, "Where did those come from?" "Oh," he says, "Well, that's up to the engineers to go out there in the field and get them." I said, "Don't you realize it can't be done?" "Oh yeah, they ought to be able to do that." I said, "Ken, it's impossible to come up with any kind of relationships for some of those beneficiaries that you're talking about and work them into a program where you optimize the operation so you get the most benefits." I said, "It don't work that way." I said, "It can't be done."

He says, "Well, it's got to be done." He wouldn't even listen to me until a few years later after be got in his business and he was doing a lot of hydrology and found out that he couldn't get some of the information that he needed. He had learned a lot in the days that had gone by as far as practical application. He didn't need to learn anymore about theory, he knew enough about that.

But he was telling us about how he used water quality storage at that time they were going strong on water quality storage and he'd say, "You can use this water quality storage for flood control." I said, "What do you mean?" "Well, you can use water supply storage for flood control." I said, "Well, that theory is all right out in the West where you've got snow to forecast runoff and you can have some idea what your floods are going to look like." But I said, "How are you going to do that out here in the East?"

He says, "Oh, well, the Weather Service, they've got this good forecasting from radar now. They know where storms are and where they're going to travel. They can see the storm coming over this area, and you've got two or three days, you can release the water out of the reservoir and have the reservoir empty for when the storm comes over the basin. Then you fill it up, fill the storage back up again."

I said, "Well, that sounds great but what are you going to tell the city fathers that are depending on that water supply to provide their M&I water for the community if the storm goes the other direction? "Well," he says, "The Weather Service, they need to know how to get forecasting down so they can predict that." I said, "Well, you're forgetting that they're not capable of doing it." So it's just little things like that if you don't think about them or pay attention to them, the theories go right down the drain.

You can imagine what a community would say if you had let all of their water supply out of the reservoir because a flood was coming when the flood didn't materialize. Then they didn't have any water for water supply. They would be really angry. Probably run you out of town and tar and feather you or something.

Q: At the very least. Well, a critical problem has always been the gap between theory and practice.

A: It's a tough one to fill because people are really oriented toward the scientific bent. Like to deal a lot in equations and procedures that are easy to work out to a neat answer. But most people who work in engineering, they got problems from their textbook that always worked out to nice neat answers. But when you got out in the field, and you try to apply them with that same procedure to actual data, it never works out.

You can't get a nice simple answer from the data you get out in the field. It just never works out. You've got to make some adjustments here or there or try to figure out why this storm didn't really give that amount of water or was there something different than they apparently observed there. Crazy things happen.

One incident I think about--I often think about when I think about accuracy of data--the Weather Service had a real big water content in the snow in a particular location where a rancher was the recorder for the snow. All the rest of the area, nothing had that big water [content]. They couldn't figure why there was such a large precip content in the snow in that area.

So they went out and they questioned the lady who was contracted to do the job. She was saying she knows darn well about that information--she is very cautious and conservative about how she did her work and careful so that she sent in the right [data]. She said, "I collected the sample snow and I melted it down and I measured the water content and I got the right answer."

It just happened that her husband was sitting in the next room listening to all this conversation. Finally he felt guilty enough and he got up and came in and said, "Hey, excuse me, I hear what you're talking about and you're having problems with the data." He says, "The reason you're having problems with that is because it's my fault. He said, "She put the containers on the stove to melt the snow." He said, "She told me as soon as it melted to take it off the stove so she could measure it." And he says, "I forgot about it and the thing boiled dry." He says, "So I just dumped some water in it and she measured the water I dumped in."

Here the Weather Service had been publishing that as an official record for some time, and they had never been able to explain why it was so different there. But those kinds of crazy things happen.

Q: Well, I would imagine when you deal with a lot of people as your data gatherers you've got that as an error probability, too.

A: Oh yes. There is a lot of that that goes on. Well, a lot of these people are volunteers. While they may be conscientious, they don't get enough money to really do it, if they weren't interested in doing it on their own. I used to go out and help sign up these people when I was in Garrison to do some of the gauge reading. We would pay them instead of the Weather Service. They'd give the data to us and to the Weather Service. But the Corps was paying them because we needed it to regulate our reservoirs.

Some of those people, they were really doing a lot of work for practically nothing. They would get like a couple bucks a reading or something like that and might have to drive five miles from their house to a gauge.

Q: How much has the Corps gone into automated data gathering where they have a remote station?

A: They do have some of that but it's so expensive that it can't really cover all of the areas. You still have to use a lot of this individual help. There are all kinds of volunteer helpers as far as rain gaugers are concerned. They have a lot more automated stations now than they used to have, but they are still far from being adequate to cover all that they would like to have.

Q: Because you're dealing in all of the basin areas?

A: Yes, the basin is so big and the variability of the rainfall is so great that the changes--well, just like in Washington here. It can be raining like heck over at my house and not even raining at your house. I measure two inches of rain and you measure zero. If you don't have any measurement device over at your house, you may assume it rained two inches at your house, too. See that's the kind of a problem we run into in getting good information on rainfall.

You can't get the gauges close enough together to be sure you've got a real accurate measurement of the aerial distribution of the rainfall. You do the best you can.

Projects Relating to the Garrison Dam

Q: Now when you went to Garrison in '53, the dam was under construction. So what kind of projects were you involved with there?

A: Well, some of the projects related to the Garrison Dam itself. I was in the hydrology and hydraulics branch. The first year I worked there I worked in hydrology. I did a lot of work on small projects--we were starting to regulate the reservoir even though the project wasn't complete, we were still filling the reservoir and we still had to make releases and forecasts on inflow and decide what the release is going to be and that sort of thing.

We were getting instructions, we had teletype connection with the other districts and also with the Missouri River Division. They would give us instructions on generally what we were suppose to do and then we would have to try to figure out--one of the problems we had, of course, in a big reservoir like that was knowing what the pool level was.

We were getting inflow based on the difference in the water surface at the beginning of

the day say and the end of the day. Then knowing the water that you'd let out of the reservoir you could figure out what the inflow was. The problem was you didn't really know what the water level was because the wind was blowing so hard. You couldn't get any real accurate information on the water surface. Just a little bit of difference in water surface made a lot of difference in Q, in inflow.

If you were off--sometimes we'd go for four or five days where we were just kind of guessing at what the inflow was by extending curves that we had developed from previous days. But until we got to a day where it was real calm, we wouldn't know for sure what the level of the reservoir was. Then we would have to go back and readjust our estimates for those previous days when we got a day where we knew pretty sure what the water surface was.

So there is a lot of guesstimating and things like that that you had to work with. Even with the best tools, you can't be that precise on those big reservoirs level. You can have gauges half a dozen different places around the reservoirs, but still when you're dealing with hundreds of a foot, that one hundredth of a foot will make quite a bit of difference in your flow. It's very hard to be that accurate.

Q: Yes, because you're dealing with some pretty large reservoirs.

A: Oh yes, those are big projects. But then that was part of my work. Then we had some levee projects. We were studying levee projects. We would go out, during flood periods, and look at damages that took place during the flood.

One of my experiences was flying out with aerial observation of flooding in the district. The pilot owned his own airplane, and he would fly it out and we would go over all the area and make observations of what area was flooded and what was happening out there just by flying over it. This guy was crazy when he was flying that airplane. He would fly under wires and he'd dive down in the valley there and he'd be steering the airplane with his knees and taking pictures. He was also the photographer.

He would be heading right at a mountain or a hillside taking pictures. Then all of a sudden he would grab the stick and pull it. It would go zoom upward. It was quite a thrill to go out with him.

Q: It sounds like it.

A: I did that on a few occasions.

Q: Sounds like one of those thrills you could bypass though.

A: I had a lot of interesting things happen when I was young.

Hydrologic Engineering Center (HEC)

Q: Did the Corps initiate any training projects for hydrologists while you were at Garrison? Was there any kind of training or was it just what you learn on the job and from your supervisor?

A: I just don't remember. I don't remember any courses really being available other than what you learn from your on-the-job training at that time when I was in Garrison. It wasn't until really the Chief's office had a few training courses before HEC was put into operation. But up until HEC was put into operation, there really wasn't any good training program for hydrology. There was no systematic training.

For example, a division office might get some of their hydrology people together in kind of an ad hoc basis and give them some advice and guidance. But there wasn't really any formal programs going on, certain courses being taught and you knew what the content of that course was going to be. If there was any training done it would be on a need-to-know basis. Something new would come out and so one person maybe in the division would figure out what it was all about and then he would get the rest of them together and tell them about it.

It wasn't something like they have now where annually they decide on which training programs they're going to conduct and they send that list out and they find out what the interest is in it. If there is not enough interest they cancel some of the courses and add some others. So it's pretty formalized nowadays. They have--I don't know what the hell they call them--each course had it's own advocate or whatever. He was responsible for making sure that all the right stuff was being taught in the course and that it had gone on a training list when it was needed and so forth.

Then, after each course the HEC publishes one of these big folders like this. There are all different courses that HEC teaches. As they learn a little bit more, the course changes a little bit.

Q: But you key a lot of that change to the establishment of the Hydrologic Engineering Center?

A: That's how it got started and got formalized. They designed courses for specific purposes. They designed hydrology courses for planners so they would learn enough about hydrology so they could do a better job in planning. You know historically hydrology, for example, has been a training ground for a lot of the planners because the basics of hydrology are what they need to do good planning. If they don't understand hydrology, it's pretty hard to do water resources planning.

That's another area where the Corps has kind of gone through different phases of how they handle things like planning or like water quality. Years ago when I first started--in that branch in Garrison District we had a sedimentation section, a hydrology section, a hydraulics section, and the reports section they called it. I worked in three of the four sections there.

But a reports section is really what we call planning today. Well, the planning at that time had a very small niche in the whole program. It was done in this reports section. But as we got into these Water Resources Development Acts by Congress, and they wanted more planning in this economic analysis, more sophisticated planners became more important all the time. It was tough to get that going the way Congress wanted it done.
Because first of all your top civilian in the district office was the chief of engineering. He had the highest grade and when the District Engineer needed any kind of a decision on the technical matter, he would go to the chief of engineering. There was continuity from year to year on what had gone on in the past on technical decisions because the same civilian stayed there usually for a long--some of those chiefs of engineering were there for years and years and years. They weren't about to start any of this new planning crap. They didn't like it and they knew how to design things, they didn't need anybody to tell them how to do engineering.

So it was very difficult to get planning off the ground. But when they did start getting planning positions, where did they go to find people to fill them? They went to the hydrology people. A lot of the top jobs in planning, the early planning bobs], came from the hydrology side of the house because they were the only ones that really had enough background to do some of the planning until the Rivers and Harbors Board [Board of Engineers for Rivers and Harbors, BERH] got their training program started so they actually had real formalized training in courses for planners where they would bring them in for a whole year and train them in how to plan projects.

Then the top jobs started going to those people that had that kind of training instead of picking from some other job like hydrology. But even the people that went to those courses, a lot of them were in hydrology and they went on and got that additional planning

experience and went into the planning field. So many of the planners have a good background in hydrology.

Q: Well, that seems to be the basis for everything in the Corps now.

A: Well, if you don't know whether the water runs uphill or downhill, you're in trouble.

Q: Doesn't make any difference how good the dam is, right?

A: You need to know about storms and droughts and all that kind of hydrology in order to do any planning at all.

Q: You mentioned the chiefs of engineering divisions. For many years the Corps was accused of being resistant to change, and largely because of the people who had been in these positions, who became virtual institutions in themselves. In your experience in the Corps have you found it to be an institution that does adapt to change relatively easily?

A: Well, I think in those earlier days it was pretty hard to change things like planning. First planning came along and that was hard to change. Finally in order to treat planning the way the Congress wanted it done, they had to actually set up separate planning divisions within the districts. So you had a planning pipeline that went up through channels. You had an engineering pipeline. The two had a hard time interchanging a lot of times.

They created a real monster by doing that for the district engineer because now he has a chief of planning and a chief of engineering, and they both have the same status. When he's got a technical problem, who does he go to? Which advice should he accept? So he would have to end up making decisions on technical matters he really is not trained to do. He was really stuck.

If the planner in most cases is more articulate than the chief of engineering, who is probably a structures man, he can convince the district engineer to listen to him more than the chief of engineering can in most cases. At least it has been my experience that the chiefs of planning, they really had a way about them because their job primarily was convincing people that this project is good and these are the things that make it good and all that kind of public relations. That was his job.

Whereas the chief of engineering, his job was to do technical things and not really deal

much with the public. He didn't have to learn all those communications skills as thoroughly as the planner did. So he wasn't able to communicate to the district engineer a lot of times as well as the planner. The planners kind of got the upper hand then over the chiefs of engineering, I think, for many years.

In all. I guess. they keep changing around. I think they're kind of almost back to where they were before now where they've got a new chief civilian in district offices who is--what do they call him now--who follows the projects. What do they call that stuff?

Q: Project management?

A: Well, it's a project management concept that was introduced a few years ago.

Q: Well, it was one of the initiatives of Bob Page when he was Assistant Secretary of the Army for Civil Works, wasn't it?

A: Well, they follow every project. One guy follows the project from it's inception all the way through, and they have real limitations on what you can do to change the project once it was authorized by Congress. So that guy apparently now is the top civilian in the district office, so now there is one guy who is the top civilian in the district office. We don't have two or more all trying to get the district engineer's ear, so to speak.

So there are advantages and disadvantages of both concepts. But it's tough for a district engineer when he gets put in [this situation]. Well, not just a district engineer but the Director of Civil Works.

For example, the Director of Civil Works, he has tough decisions to make. He has had different organizations through the years but when he has many divisions and different points of view, a lot of times he has to end up deciding what is the best technical decision. Really he shouldn't have to be put in that position because in most cases he really [doesn't] know for sure what is the best technical answer.

It is pretty hard for him to judge when the Chief of Planning says, "This is the right answer." The Chief of Engineering says, "No, it isn't, this is the right answer." It's pretty hard for him even though they both do a good job of explaining their points of view, why it is still hard for him to make that decision whether he has made the right one or not.

I don't know what the solution is to that part, but how do you avoid him having to make those kinds of decisions? But, it is just the way the Corps of Engineers works. They

don't have the continuity. The Director of Civil Works is there for three years or so, and the new one comes along and he has to learn which guy he can put the most confidence in., It takes him awhile until he figures out which one gives him a lot of baloney and which one gives him the best information. By the time he gets it figured out, he leaves.

Q: Yes, that's one of the big problems. The point being the same one that you made, too-- that they're not really technically that proficient.

A: Well, they have technical training, obviously, but they haven't been practicing it. They are so busy doing management that they don't have time to sit down and do a statistical analysis or a backwater study or a structural design problem or something like that.

Waterways Experiment Station (WES)

Q: Yes, most of those guys who go that way don't end up as Directors of Civil Works.

A: They go to the Waterways Experiment Station.

Q: Which brings up a question. When you're sitting up there in a place like Garrison and you have problems, did you get a lot of support out of WES? Did they help you at all? Were they at all involved in hydraulic studies?

A: They're very active in hydraulic studies. They're not the organization to do hydrology studies because it has never been emphasized at the Waterways Experiment Station. Especially after HEC came into the picture.

Now WES does some hydrology studies for other military elements, not the Corps of Engineers, but other elements of the Army. They do some hydrology for battlefield hydrology and stuff like that, which I'm not so sure they know what they're doing when they do it, but they do it anyway and the Corps has no control over it.

As a matter of fact, I recall one year when I was in charge of hydrology and hydraulics. The Waterways Experiment Station got a research job from another element of the Army, and they were holding a nationwide conference on what approaches they should be using to do the studies that they were doing. They didn't even ask me to come to the meeting. They then asked the Hydrologic Engineering Center to go to their meeting. Here the whole subject that they were dealing with was hydrology.

They had all the other agencies. They had the Weather Service and the GS [U.S. Geological Survey] and professors and everybody, but they didn't have the two most prominent elements of the Corps of Engineers involved in their discussions. The only way I found out about it was somebody from the Weather Service called me up one day and said, "Hey, what is going on with this meeting down there? What are you going to do down there?" I said, "What meeting?" It was ridiculous.

Q: What was their explanation?

A: They didn't have any. They never did say why they did that. They didn't have to explain it, they didn't have to explain anything to me, they don't work for me. They didn't work for the Director of Civil Works or even the Chief of Engineers when it came to that job. It was for somebody else. But it just blew my mind to think that anybody that was going to do something like that wouldn't at least contact the people that they should have been the closest to.

Apparently, they felt that they didn't want to be bound by traditional procedures that had been used in the Corps. They wanted to come up with new ideas, I guess. I don't know what other explanation they had for it.

People: Leo R. Beard and the Hydrologic Engineering Center

Q: When the Hydrologic Center was formed, was that formed from people taken from the Corps? Was it an element taken out of WES or was it just formed mostly wholly new?

A: What happened is that they had research money. All the various elements: hydraulics, hydrology and soils. Everybody got some of the research money. They had a pot of research money every year and they divvied it up depending on who could do the best talking and who they claimed they had the most needs. Hydrology got a chunk of that money, too, and they would use it for a lot of purposes such as storm studies and other useful activities.

But they were concluding a lot of those storm studies and a lot of the special studies that they had been done, unit hydrographs studies and others. A person that was in OCE, [Leo R.] Roy Beard, I'm sure you've heard of him if you've been interviewing anybody in hydrology. His name always comes up because he was the first director of HEC. But he was in the Chief's office, and he is a guy who wrote the first textbook for the Corps on hydrologic statistics.

Actually he did not necessarily develop the basic theory behind it but did the application of the theory to storms and floods. He developed a book on statistics for the Corps. It turns out that it is the same technique that the interagency hydrology committee agreed to use today and published it in a document called Bulletin 17B, *Guidelines for Flood Flow Frequency Analysis.*

He was a real sharp guy in all areas of hydrology. Statistics was his primary field, but his wife didn't like Washington. So, Al Cochran didn't want to lose him from the Corps, he wanted to do something to find a place for him so he would stay in the Corps. Roy wanted to go back to California. So Al got together with Gomez out in Sacramento District. He was Chief of Engineering, I think, at that time.

He said to him, "Do you have a place for him in Sacramento? Could you find a spot for him to work out there?" So Gomez says, "Yeah, we can always use a real top notch guy like that. We'll put him in charge of a section." He was put in charge of the water control management section there in Sacramento. Of course, that created a little bit of problem because he came in at a higher grade then some of the other people had out there. They didn't reduce his grade when he transferred. That created some problems as far as in-house concerns. And it wasn't too good from that standpoint.

After he had been there for a little while, Al came up with this idea. Why shouldn't we have some place where all special hydrology work is done independent--not completely independent but at least have it's own home. Roy happened to be in Washington for some other purpose, and Al took him out to his house for about three days or a weekend to tell him all about his ideas on what they ought to do.

As Roy says, "I listened. I didn't get a chance to say much." But when Al got all through with his ideas they had come up with a concept for the Hydrologic Engineering Center. It's not much different than it is today. They would use money from research to get this thing started and just have a few people to begin with.

They talked to Gomez in the Sacramento District about taking charge of all the administration that needed to be done for the Center. But they decided that it shouldn't be located right within the same building as the Sacramento District because it had its headquarters ties and headquarters would really be telling them what to do. So they didn't want it right in the District.

They moved it out to Davis on the grounds that it was close to the university where they'd get all this theoretical input and so forth. They moved it out there with a small staff to start it off with, and it just gradually grew and grew from there. By doing good work they

were able to get more and more money to do more things. It not only became a great organization for hydrology, but planners really wanted to use it, too. It got so that it was doing more and more planning.

They added a branch, a Planning Branch, to the HEC after it had been in existence for a while so that it served not only hydrology but planning, too. For quite a few years the hydrology people in Washington called the shots and got all the money for it. Then, as time went on and it got more and more involved in planning, they had some reorganization on who was going to call the shots for HEC.

The Institute for Water Resources [IWR] ended up being the ones that theoretically were their bosses. Although they didn't have much capability to give them technical direction except in the planning area. So the headquarters hydrology people still had to go out there for the annual meetings.

I guess they still do have an annual meetings where people from headquarters and any of the field offices that want to attend. They would go over the program that HEC was proposing for the next year and give them direction by saying, "We don't like that too well. Spend more time on this and less time on that. What are you going to accomplish and what have you accomplished?" Those meetings used to be pretty interesting. We'd get into some pretty heated debates sometimes about what was most important.

Q: So they would come up with a theoretical research program then for a fiscal year?

A: Right.

Q: Were they doing reimbursable work at the same time as that?

A: Some were, yes.

Q: But mostly research programs?

A: Well, a lot of their funding through the years has been reimbursable work. A district would have a special problem and, rather than going out to private interest to get the job done, they would go to HEC. The whole concept was, "Hey, give us your tough problems. If you've got a tough problem that you're having a hard time figuring a way to handle it, give it to us and we'll try and solve it for you. That way maybe we can apply

some of this theory that people have been giving us and wanting us to try out. Maybe we can work it into a solution to the problem that you've got."

So they did, in essence, come up with a lot of ways of handling special problems simply because they were this group that handled communication gaps. The districts really didn't know how to apply some of those theories to the interesting problems that they might have. The problem I had was trying to control districts who wanted to use HEC as just another source of help. Just routine help. I said, "Well, we don't want to use the resources of HEC for routine help." If you don't have something special to do, go out and get a consultant to do it. Don't use HEC, go to some other district and use them.

Q: You didn't want to destroy their research program for that kind of thing.

A: You see they always have been pretty well constrained on how many people they can have. They didn't want that place to get too big. Their numbers have been like about 30 full-time people, 32, maybe 34 or something like that. But they never have been able to expand it much beyond that. Headquarters just doesn't want to make it a real big outfit. They could have some temporary help, but they just didn't want to make a massive organization.

Q: From a hydrologist's point of view, has that been a good decision or a bad one? Would you rather see it go larger and do more things?

A: Well, I think there is a danger in having to be too big. The danger is that pretty soon it doesn't have enough work. So what it does is, it goes out and takes all these routine jobs from the districts and the first thing you know in the districts, they've got problems and constraints on help and so forth. If they know that they can get the work done at HEC, then they'll eliminate the hydrology staff in their district and say, "Hey, we can get along without them. HEC will do all our work for us." I think that's bad when it starts doing that sort of thing.

Q: Because the districts really need to have their own hydrologists.

A: They need to have a hydrologist--they've got to have them. Especially if they are a district that has reservoirs, because the people who really have the knowledge on how to operate reservoirs are the hydrology people. They're the only people who really have the

background experience to know how to effectively operate reservoirs and how to get the most out of the storage. How to do the reservoir regulation studies.

That was one little problem that I had with John Morris when I first came to Washington. He was the Director of Civil Works. He had some concepts when he was in Missouri River Division of putting the water control management that McClendon was in charge of under the Operations Division. His argument for doing that was that, "Hey, the people who come in contact with the general public are the operations people. They're always asked questions about, 'Why are you making these release rates?' None of them know what the answer is." They said, "Well, you've got to call McClendon. He's the one that decides all of that."

General Morris said, "Water control management ought to be part of the Operations Division." So we had a little argument about that one day in his staff meeting, and I told him, "You really don't want to do that." I said, "In the first place the people that know how to do water control management like McClendon come from a hydrology background. When you get into district offices where you have water control management responsibilities, they don't have extensive work all year round. They have a lot of work to do during floods and during emergencies and droughts. But they don't have a nice steady load so to speak."

Their load varies. So if they are a part of the hydrology group, they can work on planning studies or design memorandum studies when they're not doing their water control management. So you get more effective use out of them, you get to use their hydrologic knowledge. Otherwise, if you didn't do that you'd have them doing some routine thing that didn't take advantage of their expertise in hydrology. You'd have them out there mowing the grass or some darn thing just to keep them busy.

Anyway, he didn't argue with me about it. He just said, "Well, I still think there is a problem with communication between the public and the people who decide on the release rates. So you need to pass that information out." I have to agree with him on that. But it is just his concept of how it was going to be done that bothered me. He never did anything about it after our conversation unless he kind of decided, "Well, maybe just let it go or something." He never moved on his proposal, and I never heard anymore about it from him after that.

Lloyd Duscha

Q: Well, didn't he tend to favor operations anyway?

A: Well, surprising to a lot of people, he wasn't as interested in engineering, for example, as he was in planning and operations. But he was one of the most ardent supporters of Lloyd Duscha, who he brought in from MRD. Practically twisted his arm to get him into Washington. He was the one who really pushed him for being the top civilian in headquarters, which he was for a while. He was really the top civilian. I think he had the highest grade of any civilian in headquarters for a while.

John Morris was the one who was pushing him. So you couldn't really say that he wasn't concerned about engineering. It might have been that he was so used to having Lloyd out there, who was very competent doing a real good job that he didn't have to spend much time worrying about it. That most of his administrative duties led in other areas, you know, where he had more problems then he did in engineering. So that might have been why people were saying, "Well, he is not as interested in engineering as he is in planning."

Q: You tend not to be worried about things that you know are handled right.

A: I think that's true. If you've got somebody in a job who is really doing a great job and you know it, and you hardly ever have a problem there, why are you going to spend a lot of time working on that area when you've got a bunch of problems in other areas. It's just that the engineering didn't require his attention as much and so, I think, that is probably why he got that reputation.

Francis Slichter and Wendell Johnson

Q: You talk about Lloyd coming out of MRD. So did a lot of other ones including yourself, but I mean people like Francis Slichter and Wendell Johnson, they came from MRD.

A: They came from MRD. Well, I think MRD for many years, in the early years when they had the Pick-Sloan Studies going, they were the biggest organization of the Corps as far as doing big engineering studies and interagency activities. They were probably more active than any other division in the country at that time. So they were obviously the ones that probably had the most competent people to come into Washington.

Francis Slichter and Wendell Johnson were both real top-notch guys anyway. You just walk into a room and those guys stand out. You don't even have to hear them talk or anything. You just look at them and say, "Dang, that guy must be pretty distinguished."

Q: What were they like? You probably knew them fairly well.

A: They just had an air about them that they were very confident in what they did. They didn't act like they were the least bit uncertain about what they should do. They seemed always to present an air of confidence. When you talked to them, they would listen to you very closely. If they agreed with you, they would tell you. If they didn't, they'd tell you why they didn't agree with you.

They were very supportive of their staff. I've never had anybody that I know of that ever made serious complaints about either one of them. None of the branch chiefs ever. They always had a real great respect for them. They used to call them "Mister" all the time, even though they knew them real good, and most of them did, and they still said Mr. Slichter or Mr. Johnson. They didn't say Wendell or Francis. It was just the way they did business maybe in those days.

Q: Well, I know many of the people that I've talked to, including a lot of their top generals, division engineers and district engineers from Mm--people like Tom Hayes--always had a great respect for them.

A: I think they were respected all through the Corps and world-wide for their [work].

Q: Yes, they were more than just engineers in the Corps of Engineers. They were certainly recognized for their skills.

A: Yes, another thing about it that kind of impressed me being a civilian working for the Corps was these fellows. When they walked into a room with a bunch of generals, they didn't appear like they were subservient to these generals. They acted like they were the top guys, just as high or higher than the generals were, you know. Generals didn't bother them at all. They'd talk back to generals just as quick as anybody else. It didn't seem to bother them at all, a four-star general or a three-star general or whatever it was. They were just as comfortable telling them what they should do.

Q: Well, when they've been around a long time people like that, they probably saw these guys as captains and majors, so they think of them as kids.

A: They've been around quite a while, they saw that three-star general when he was just a light colonel, so they're probably not as overly impressed with them as somebody who had never seen them in that lesser role.

But, anyway, it was just kind of funny to me that a lot of the people around, they were always kind of acting like, "Gee, should I even talk to this guy because he's a general" But I never saw those guys ever appear like they were uncomfortable dealing with them.

Redesigning Projects

Q: A while ago we talked about redesigning projects. We were talking about the maximum flood storms. What would you do if you redesigned a project, like BuRec? You said they were redesigning their projects. Would you redesign to give the pool more capacity or would you put more capacity on the tributaries?

A: Well, every project is different--there are practically no two projects that are exactly the same. In many cases, the answer is to make the spillway bigger because it is usually cheaper to make a bigger spillway than it is to raise the height of the dam. It is very expensive to raise the height of a dam. So usually they try to figure out some way to pass more water without causing a problem. In some cases, it is possible; in others it isn't. Like you say, they could also, for example, put another dam upstream that would give them additional total storage to help take care of the big flood. But, of course, that gets kind of expensive too.

But there are a lot of different kinds of solutions that are used. For example, in the Non-Federal Dam Safety Program, in order to do a really intense study, what they called the follow-up study of the initial hydrology and hydraulics, they'd get into a detailed analysis of the dam after it had been declared unsafe. They'd go back and make a restudy. That would cost quite a bit of money to do that more in-depth study.

Some of these dam owners, rather than spend the money to go out and do more in-depth study, would spend the money and widen the spillway or make it a little deeper, big enough to take care of that probable maximum flood that they had come up with in the initial study rather than to make sure that it was the right answer. So it was cheaper for them to send some bulldozers out there and make the spillway bigger in the small dams than to spend all that time studying it. "Hell, we don't get anything by studying, all we

get is another answer--It don't help the problem any. So I'll spend my money doing something constructive." There are a few of them that did that--maybe they don't have the exact answer but they still got a lot more capability than they had before.

The Distinction between Hydrology and Hydraulics

Q: Now something else you mentioned was the Hydrology and Hydraulics Branch. You've already said hydrology is not hydraulics, and WES and the HEC are two different things. Do you want to make that distinction and definition in terms of the difference between hydrology and hydraulics?

A: Well, of course, hydrology and hydraulics have been pretty much together, even though we have two different terms there as far as working relationships because they're so closely related that you don't really know where one ends and the other begins. There is some overlap area there where hydraulics people handle it or hydrology people.

Years ago when this first got started, everything was called hydraulics. There was nothing in the Civil Service register regarding hydrology. There was no such thing as a hydraulic or a hydrologic engineer. You were either in engineering hydraulics or you were in hydrology or sedimentation. I mean your basic engineering was hydraulic engineering. Then under that came hydrology and associated activities.

A lot of the people in the hydrology area said, "Well, hydrology is really more prominent than hydraulics." The hydraulics experts said, "The hydraulics is really the most important." Does hydraulics include hydrology or vice versa, you know, and so on. You don't really find any hard and fast definitions, I don't think, other than design hydraulics for structures, such as spillways, outlet works, and things like that.

There is no question about that being hydraulics. Now when you get into things like backwater studies, in a lot of cases they say, "Well, if it is a natural channel, the hydrology people do it. If it consists of improved channels, with structures in them, with drop structures, with concrete walls and concrete bottoms, or whatever, pipes and stuff like that, then it is hydraulics." But as long as it is natural terrain, then it's hydrology. So, maybe that is part of the distinction.

But, anyway, Al Cochran liked to include practically everything in hydrologic engineering--everything was subservient to that. He was the one who got the hydrologic engineering definition started, and I think a lot of places use it now where they didn't use to. They never used to use it at all. It was either you were a hydraulic engineer, and you

worked in hydrology. But because civil service didn't have any other designation for it except they did have a hydrologist, which wasn't in the engineering side of the house.

Q: Well, the pure science type.

A: Nobody wanted to be labeled as hydrologist because they didn't get as high a pay as the engineers did. Nobody wanted to be a scientist; they wanted to be an engineer. That was in the early days, too, before other disciplines got more recognition, like the economists do get a lot more recognition than they used to. Biologists get a lot more recognition and people working in other environmental aspects.

Q: Wasn't one of the significant aspects about the whole planning division that it now has many more social and behavioral scientists than it has just engineers?

A: Yes, they got away from the engineers running the Corps. The Corps at one time, if you weren't an engineer, why you just might as well get out of the Corps as far as going up the career ladder. You were limited in how far you could go. You maybe could get to a GS-14 at the maximum if you were a social scientist or something like that. The planning side of the house gave opportunities for a lot of those other disciplines.

The economists got to be top dogs in planning. Gedez was Chief of Planning at one time, and he was an economist. I don't know some of the others who managed to get up there. The Corps of Engineers is not necessarily the Corps of Engineers anymore, but the Corps of a lot of disciplines, not just engineers.

Q: Engineers, planners, social scientists.

A: Most anything you could think of.

Q: In the H&H Branch, which we were talking about, when hydrologic engineers come to the forefront, were there people like Cochran involved in getting changes in the whole civil service system?

A: Well, they served on committees. Civil service would have committees to decide how to name various jobs and what kind of names they should have and some of those people

were involved in cornrnittees. Well, I think Lloyd Duscha has been on some committees.

But the makeup of headquarters, of Hydrology and Hydraulics--you'll hear more about it from Jake [Douma] when you talk to him. But when I first went in there, there wasn't much of a hydraulics section per se. There were only two people working in hydraulic design. In OCE they had designated everything outside of hydraulic design as hydrology. They even called the branch that Al was in charge of Hydrology and Hydraulics.

The other group that Jake Douma was in was a Structures Branch, and he was an element of the Structures Branch at that time. There were two people working in hydraulic design, and he was one of them. There was another one who worked primarily in the area in Florida, on the Central and Southern Florida Project. But Jake did most of the other hydraulic design work.

Then hydraulic design started doing more physical modeling down in WES. They needed more help and they got more into the navigation research, and they were doing a lot of navigation-type engineering that the hydrology and hydraulics branch didn't do.

Then they were more involved in the coastal engineering. So the coastal and the hydraulic design part of dams and levees became the big things in the hydraulic design. They really ended up with three sections in the hydraulic design branch--coastal, navigation, and riverine hydraulic design.

But hydrology really didn't get much into the coastal area. Especially into the detailed analysis of coastal studies because there was a Coastal Engineering Research Center [CERC] anyway, doing that kind of engineering. But the people who were directing activities were in OCE and were the hydraulic design people, not the hydrology people.

So, then after a while, let's see, when Al left we were still the Hydrology and Hydraulics Branch. Finally, I guess, when Homer Willis was Chief of Engineering, they decided to make hydrology and hydraulic design one branch. I was in charge of hydrology at the time and Jake was in charge of hydraulics.

Jake being the senior man, obviously got the nod since he had been around a lot longer than I had. It was a natural thing that he would be in charge. But he never really had much background in hydrology, and he wasn't really interested in it either. He didn't really want to be involved in hydrology, and he just pretty much let me do my thing and he did his thing. Even though he was the branch chief at that time, he didn't really give me much direction other than administrative type things.

So, then when Jake retired, I took over as the head of Hydraulics and Hydrology. We even argued when they named the branch, should it be Hydraulics and Hydrology or Hydrology and Hydraulics, which one came first.

Q: Which "H" came first?

A: Yes, which "H" came first, or what did the first "H" mean. Then it got even more complicated for a while. General Bratton [Lt. General Joseph K. Bratton, Chief of Engineers, 1981-84] decided that he wanted to put all the engineering under military engineering. He didn't want to have two engineering divisions.

But Gianelli didn't want everything to go to military engineering because that was out of his jurisdiction. He wanted the control over the hydrology people. So, in that question there was a big battle. That is when I really had a lot of action going on. [Major General] John Wall was Director of Civil Works. Lloyd [Duscha] wanted to take the hydrology and hydraulics with him over to military engineering [Directorate of Engineering and Construction].

They kept asking me what I wanted, and what I thought was best. My central theme, and I beat the drum as hard as I could and as often as I could, to keep it all together. Don't split up the hydrology and put some of it in the Civil Works and put some of the hydraulic design [in Engineering and Construction] because obviously some of the hydraulic design was more related to engineering than it was [to] planning and obviously some of the hydrology was more related to planning than it was to "hard engineering," so called. Like Homer Willis] used to say, "hard and soft" engineering.

But, anyway, everyone who talked to me about it, or would listen to me rather than just come and talk, anybody that would listen to me I'd say, "Hey, I don't care which way you put it, whether you put it in Civil Works or put it in the military side. Just keep it all together. Please, for God's sake, don't screw it all up by subdividing it up into different parts." Well, not only that, part of the hydrology was directly related to the operations, too, in the water control management.

So they could have split it up three ways. They'd have gotten nothing out of it. We would have no power at all.

More People: Major General John Wall

Q: But you wouldn't put it beyond them to do that?

A: Well, Lloyd was willing to do it, and John Wall was willing to do it, and Gianelli was willing to do it, and, I think, General Bratton was willing to do it. But I was the only one who was saying that it shouldn't be divided up. But for some reason, I don't know why they did, but they listened to me and decided to keep it in Civil Works because Gianelli was so strong all the time on having something to say about what hydrology did.

Lloyd agreed to it because he knew me well enough, and we had worked together long enough. He figured he could still work with me even though I wasn't in his division but he did it reluctantly. I mean he wasn't really enthusiastic about it. Whoever was the Director of Military Engineering at the time really didn't give a damn one way or the other. He could care less.

Then they asked me, "Well, what does your organization want to be? Do you want it to be a division, branch, office, etc." Well, we didn't even know what to name it. But we finally ended up saying it was a division, even though it was a light division compared to the others. They called it a division while I was there.

So we were a division for all the Civil Works staff meetings and things like that. But all the other division chiefs had a higher grade, and they had a lot more people working for them. But, anyway, it worked out all right as far as I was concerned because I was able to work for Lloyd, and John Wall never did worry about that at all.

As a matter of fact, he encouraged close cooperation between Lloyd and myself, and I didn't have to go through him on any of the things that I was dealing with Lloyd on, especially on the hydraulic design. He didn't even want to hear about it. The only thing he wanted to be involved with was anything that Gianelli was concerned about. He says, "Anything that Gianelli is concerned about, I want to hear about that. I want to have something to say about it."

Q: Well, I was chief historian for the Corps for a number of years. General Wall had us do a special study of the Office of the Assistant Secretary of the Army for Civil Works.

A: Well, Wall, he was a special person. There was nobody like him, I don't think. He's a one of a kind for sure.

Q: Oh yes.

A: You know a lot of people didn't care for him, but I liked him.

Q: Well, you knew where you stood with him.

A: Oh yes. He always treated me good. He'd listen to my side of the story and even though he'd get different advice from other people, he still would listen to what I had to say. He didn't always agree with me but he would listen and then make his decision. But I always told him out flatly several times, "John, what I'm telling you is for your own protection. You don't have to agree with me and do what I'm suggesting, but you need to know about it before you make the decision. You'd be unwise to make a decision without knowing about what I'm telling you. So you better listen to me when I tell you about this." He took it in that context.

He agreed that he really should know about that. I said, "It's bad for you to be given advice on doing something without knowing the ramifications of it. Now you really need to know what the hell the outcome might be if you make that decision." So he would take it gracefully. But he would really get wild at times though. He knew he had to do something when I'd tell him about field issues. He'd say, "God almighty, that's going to cause a lot of problems. I've got a General out there who just doesn't want to do this." But anyway' it worked out pretty good.

Q: The politics of dealing with the Directors of Civil Works and the division engineers have got to be really a painful thing sometimes.

A: I got one general pretty mad at me. He would never speak to me again. Just because we had a disagreement over at the Rivers and Harbors Board one time. I just couldn't agree with what he was saying. He didn't like me to tell him something different apparently because he never would speak to me again.

Q: Well, just as long as they don't come in to be your boss.

A: Well, I was pretty sure this guy wasn't. I knew he wasn't as a matter of fact.

Q: Well, that's okay then. You don't have to worry too much about that.

A: Well, of course, I guess at the time it wouldn't have made too much difference anyway. If he had of come in, I would have retired.

Q: Who was that?

A: That was Tommy Sands.

Q: Oh, Tommy Sands. When he was down at LMVD [Lower Mississippi Valley Division]?

A: Yes. Nobody comes from LMVD to be the Director of Civil Works. At least, I had never heard of any of them who ever did.

Q: Well, they've got one up here now who is acting director, Art Williams.

A: Yes, that is a switch.

Q: But he's a different person. He is a very solid person.

A: Usually, when they put them down in LMVD, that is their last job before they retire.

Q: I don't think so in this guy's case. I think Art might have a pretty good shot at being the next Chief.

A: Well, that wasn't always the case for that type of thing. Let's see there was Rollins [Major General Andrew Rollins]--didn't he come in as deputy chief?

Q: Yes, he was deputy chief.

A: He was deputy chief after he had been division engineer.

Q: I'd like to begin by asking you if you have any additional thoughts about what we talked about last time?

A: Well, I don't know. We kind of jumped around from one subject to another. I guess you'll straighten that all out. But I don't know whether there will be duplication.

Margaret Petersen

Q: Well, that's one of the advantages when you get one of these texts back--you can take bits and pieces and move them around.

A: When I looked over a couple of things that might be of interest to you, one thing that I thought might be interesting was an article by Margaret Petersen, who was active in hydraulics throughout her career in the Corps. She is very active in ASCE, too. But she has an interesting perspective on the Corps and her whole career practically was in the Corps. She is now doing some teaching work. But she is still in ASCE.

This article was published in a book called Sons of *Martha* by the ASCE. Jay Frederick was the editor of it. He used to work for the Corps, too, in hydrology and hydraulics. He is also in the educational business now. But you can have that. I made a copy for you. There are some things in there that might be of interest and might give you a little background on some of the hydrology and hydraulics.

She was in on some of the early phases of hydraulics where they had to come up with new ideas in hydraulics, and develop new ways of doing things.

Q: As a matter of fact, in preparation for today's interview, I was looking at her book *River Engineering,* last night. So it's interesting that you bring her up.

A: Well, since she's one of the first females, or one of the early females anyway, in the *Corps* of Engineers, and she had a pretty good career I think.

Q: She must have been one of the very few with a 40-year career.

A: Oh, I don't know of any who had that long of a career with the Corps. But there's a lot. There were quite a few women that have been in the Corps. A lot of them are not in engineering, of course.

Q: That was pretty rare, wasn't it, in your days, if you go back and think about the '40s and the '50s?

A: There were no girls in an engineering course in my school. I remember when I got to work for the Bureau of Reclamation, there was one gal who was an architect. But we didn't have any female civil engineers in the Bureau of Reclamation. When I got into OCE, I hired the first female engineer in the H&H business. In OCE, they had never had one before. I don't think they have any now either. I'm pretty sure they don't. For a while we had Nancy Lopez, who went over to the Department of Interior. She has been over there with USGS for quite a while now.

Q: I met her when I first came to the Corps, and we were in some kind of program together on something. I forget what it was. But we did meet and talk. She was very impressive.

A: Well, I found that some of the early gals that I ran into in engineering all seem to be out to prove something. They've got to prove that they are better than the men, not just as good as the men. But since I've been over in private practice, I see they've got a lot of female engineers in various disciplines. There are as many or more women as there are in men in the office, I think, and professionals, too. So I don't have that same kind of opinion--I don't think they're nearly as concerned about having to prove that the women can do as much as the men nowadays because it is pretty obvious that they can.

Most of them don't have that over aggressive kind of a behavior that a lot of them had. I know the GS [U.S. Geological Survey] had some that were like that. They really had to get in there and assert themselves all the time. Even though when they really didn't need to, they would do it anyway.

People to Talk to in the H&H Field

Q: So that was more of a societal change that the Corps was undergoing while you were there?

A: I got a list of a few people you might want to talk to--it's far from a complete list or anything. Just the few people that stuck out in my mind that I might mention. Now we mentioned McClendon before from MRD who was very effective in this business. Another one, Al Harrison from the MRD office, who was more in hydraulics and not so much in hydrology, but he was in charge of both disciplines when he retired.

Q: Now they're both from MRD?

A: Right.

Q: But McClendon's still alive you say?

A: As far as I know. He didn't continue in engineering activities. I think he was so interested in rebuilding automobiles that he spent all his time working on rebuilding automobiles. But it's kind of interesting how some people change--I don't know I guess in all disciplines you find this.

Like Verle Farrell, who use to be in the Chief's office. He was Chief of Hydrology and Hydraulics for about a year when Al Cochran left. When they took away our Grade 16 for the head of the group, he decided that he might as well retire because he had such a profound interest in the bird dog business. He liked to judge and participate. He had his own valuable dogs that he took to these contests all over the country. He'd spend all his time doing that when he wasn't working in hydrology and hydraulics. He is still active in it.

Another one would be Bill Eckert, who was Roy Beard's follow-up as Director of HEC. He originated some of the HEC programs. Did the programming on HEC II and HEC V, and he has an interesting background in hydrology.

As far as the experimental station [Waterways Experiment Station], I think Henry Simmons--he is primarily hydraulics but what little hydrology they did, usually came under him, too. In Cold Regions [Cold Regions Research and Engineering Laboratory, CRREL], another person would be Gunther Frankenstein. Of course, there are a lot of people over in IWR who have had some background in hydrology and have dealt with some aspects of hydrology, dam safety, and risk analysis.

I was trying to think of people that were, at least during my time, prominent in some of the different offices. At LMVD, Bob Louque comes to mind. L-O-U-Q-U-E is how I think he spells his name. In the North Pacific Division, Dave Rockwood, and then in the Seattle District, Norm MacDonald. Norm was probably one of the top people in hydrology in the district offices. He was very competent.

Another one like that was Tom Riley in the Pittsburgh District. Those two fellows were in the business for years and years and years and knew just about everything you could. At NCD, Don Leonard. I don't know if he is still there or not. He got to be Chief of Engineering in NCD.

Then SWD, Terry Coombs, who is now, I think he's Chief of Engineering in Fort Worth or he has a different job in Fort Worth now. Then as I mentioned, Margaret Petersen would be a good one. Those are some of the people that have come to mind.

Q: Okay. Well, I'll pass those names on and see what they can--if they can find them, which they usually can.

A: Well, usually what happens if you go to the office that they worked in, somebody there usually has an address on them or has kept up with what they're doing.

Career Ladder in the H&H Field

Q: We'll try to track some of them down.

A: One of the things that we probably talked a little bit about last time was a career ladder in H&H. In the early days, it was tough to really keep people in the H&H discipline because the career ladder didn't look that good. About the best you could do was to be Chief of Hydrology or Hydrology and Hydraulics, or whatever they called the particular office in the district or in a division.

The highest grade anywhere in the country was a GS-14. There were a few 15's in the research business but not in the day-to-day work. A lot of the younger fellows, after they had worked in hydrology and hydraulics for a little while, they would move over into another discipline where they would have a better opportunity to get ahead.

Someone in hydraulic design might get over into structures, or someone in hydrology may move to planning so they would have a chance to get ahead. They knew if they stayed in hydrology and hydraulics, they would be typed and there was no opportunity for advancement.

Now there were a few people that got to be Chiefs of Engineering or Chiefs of Planning when they started off in hydrology. But it got so they were few and far between. Even in later years in my career, why it got so that in Engineering they just didn't feel that the people working in hydraulics and hydrology were as qualified for being Chief of Engineering as somebody that worked in geotech [geotechnical] or structures.

As a matter of fact, most Chiefs of Engineering felt that the Chief of Engineering should come from a Structures Branch. It's pure and simple, if you come in from any other role, why then you didn't belong as Chief of Engineering.

Q: I was going to say, the geotech guys I've talked to always felt that they were discriminated against.

A: Oh, they were.

Q: Just like you guys were?

A: The structural people had the top priority, and it didn't seem to make any difference whether the people had managerial capabilities or not, if they were well known for their structural capabilities, why they would get selected a lot of times. But that kind of changed, as planning took on a stronger role.

But in the early days, why structures was the only way to get to be the Chief of Engineering. Then, in later years, why they still had a policy--if you're going to be Chief of Engineering.or any other division, why you needed to have a broad background. They wanted you experienced in a lot of different areas. They would like to have you experienced in structures, geotech, hydrology, and hydraulics.

They even started a lot of programs where they would swap people around. They would trade the chief of one discipline with the chief of another one, even though they knew very little about the other discipline they were going to be in charge of. I think, by doing that, people got a lot better appreciation for all the problems and concerns with the other discipline. It helped them, I'm sure, to become Chief of Engineering.

But, if you didn't have that structural experience, it was tough to get to be a Chief of Engineering. Although there got to be to a point, as I think we mentioned before, that because the planning chiefs were so articulate and they would have preferred to be Chief of Engineering than Chief of Planning, when the job came open as Chief of Engineering, often the Chief of Planning moved right over to Chief of Engineering. They wanted that, they preferred that job to being Chief of Planning.

Q: Like you said before, that has always been seen as the job to have in the division or district, isn't it?

A: Yes, it has been in the past. I don't know whether that is going to continue. I don't even know that it does continue today, but it certainly did in the past because the Chief of

Engineering was always viewed as the guy who was suppose to be the most knowledgeable about the Corps of Engineers' activities. That prevailed when Lloyd [Duscha] came into Washington. He became the top civilian, as I mentioned before. Everybody looked up to him as having the choice spot in the Corps as far as a civilian was concerned. He was recognized world-wide because of that particular job.

But, anyway, getting on to this, how we finally got some improvement in the career ladder. We came up with a concept of a Water Control Management Branch within the division offices to not only handle the hydrology and hydraulics but primarily the big responsibility was operating all the reservoirs and taking care of all the management activities that went along with that. That was tough to sell but that finally got the blessing of the headquarters.

In most of the divisions that gave a Grade 15--there were several of them around the country now--people began to say, "Hey, if I stick in hydrology and hydraulics, I may get to be a 15 in division office." Well, that was the same grade as the Chief of Engineering in the District, so it looked pretty good. So there were more people that stuck with it, I think, after they found that there were opportunities.

There were a few divisions that never did adopt the job because Planning and even Engineering kind of objected to having it. Planning didn't want to have it if it wasn't going to be in planning. If it would have been in Planning, maybe they would have liked to have it there. But in Engineering, a lot of them didn't even push for it. They finally got them in most of the division offices.

Those positions have played a key role in a lot of the big water management problems we've had around country. They had a place to go to that really had some responsibility in that area.

Q: That's really one of those questions of professional jealousy more that anything else--the people in the Structures and Engineering Division just didn't concern themselves with your special discipline or they just didn't want to see your people rise up. But that's sort of self defeating though on their part to operate like that?

A: One of the things that made it very difficult for hydrology and hydraulics, there was no exact spot for it. The hydrology people did all kinds of work for planners to get the plans put together for feasibility reports. They needed all this hydrology in the planning.

Engineering not only needed the hydrology, but they needed the hydraulics and hydraulic design to go along with all the engineering studies that were being conducted. They had to have hydrology and hydraulics.

Then when you got over into the operations, the people who did the physical movement of the gates and so forth, they didn't really have any background on why they should change those gates and so forth, other than people would complain about what they were doing. But they got their direction from hydrology and hydraulics people who had the experience in doing all the studies to decide how you needed to operate those gates.

It was like serving three basic elements of the Corps. Yet you had to put them someplace? and where do you put them? It started off traditionally because they were in engineering to begin with and so was planning and everything. It was harder to take them out of engineering and put them in one other area when they were already in engineering. Of course, no division chief wants to lose any of his branches because he'll lose part of his responsibility and probably some of the justification for his own position.

It always was a constant problem [of] trying to decide who would handle that one. Let's see, it was the Los Angeles District. They even moved the people who were doing the water control management into the Operations Division. They took them out of the Hydrology and Hydraulics and put them in the Operations Division.

A fellow by the name of Tatum--you probably heard of him, I don't know. He has a hydraulic model, a routing procedure, named after him. He's done some individual things in terms of hydrology and hydraulics. Very active out in the Los Angeles District. But because it was important out there in operating some of those projects, they wanted the guy that knew the most about it, right in the Operations Division.

It worked. We didn't like it when they did that because it started fragmenting the capabilities of the discipline. I always thought that it would have been better to have hydrology and hydraulics in a separate group, so that they weren't directly under Chiefs of Planning or Chiefs of Engineering or Operations, any of them. Then they could provide a service for all of them and be impartial because when you're under one, it is very difficult to be impartial because your boss makes it almost impossible for you to be impartial.

Q: It's like a special staff office then?

A: Well, in a way we were a division in Civil Works there for awhile just before I retired. It was almost like that, except even though we were assigned to civil works, we were still kind of serving like I thought we should serve. Maybe it should have been, if not called a division maybe some special office or something and with a fairly high grade. Maybe not as high as the Chief of Engineering and Chief of Planning but at least have a pretty high grade so that it would have some recognition.

Throughout the years, there was always a lot of concern from the field offices about what hydrology and hydraulics people were doing. Even when you'd go to a conference and the headquarter's office, for example, would have a lot of comments on what a district had done on one of their reports. Things that really should be changed, and they became the subject of debates.

The people in the districts said, "Ah, we shouldn't change the district engineer or the Chief of Planning report. We can change all that later." But changing something later can be very traumatic sometimes if it is going to impact some Congressman's district. If the district engineer promises him a project and then you get it authorized and you can't build it because of changes in hydrology or hydraulics or any other changes later on, then he blows his top at the district engineer. The district engineer then might have a little trouble being a general.

But, anyway, politics always gets in the way of doing things impartially. But it just seemed to me if the hydrology and hydraulics element hadn't had to report directly to one of these other guys, they could be a lot more impartial in providing information.

Q: Did you or anyone else ever try to get that done in any of the districts or divisions?

A: Well, I don't know that it ever got anywhere. There were a lot of people who thought about it, thought it would be nice if they could do that but they never got any encouragement from anybody. So it was very difficult to move ahead. It was very difficult developing those Water Control Management Branches in the division offices. That was tough. But somehow Al got that started. He was able to get the first one or two going.

He'd keep putting pressure on all the Chiefs of Engineering in the division offices every time he talked to them about establishing a Water Control Center. His persistence paid off in a lot of ways, I think. It helped the organization a lot.

But, anyway, that gives you a little bit of a flavor for how they got some sort of a career ladder for the discipline.

Q: You must have been sort of the career manager then for hydrologists in the Corps in your position?

A: Bight, I was.

Professional Development Program for H&H

Q: Now I know there is a very sophisticated professional development program for scientists and engineers in the Corps. So when you were beginning, when you were planning a career for a hydrologists, did you have that in the 1960's? Were there enough schools producing hydrologists that you could get a pretty good selection for interns or trainees and enough post-graduate course work that you could train these people?

A: Well, as far as hydraulics was concerned, there has always been a good training resource in the private sector for hydraulics. Maybe not so much on dam design, but on other phases of hydraulics, but not as much in hydrology. We almost always had to depend on in-house training of some sort for hydrology background.

At one time, there was a lot of demand for the courses in HEC to be given to private people, other agencies and so forth. The Corps really didn't have the resources to train everybody in hydrology. So they started trying to get universities and private firms to teach some of these courses. It's been quite some time, there have been schools like Penn State and University of Texas, Colorado State, I think, are probably the ones.

But there are a lot of schools that have courses. Missouri School of Mines is another one, I think. There are a lot of them that have courses in hydrology and hydraulics both. Some of the people that worked for the Corps would go to work teaching or they would get a job with private industry someplace. They would start teaching a course on hydrology and hydraulics in the summer, usually between the major sessions. There were quite a few courses available that way. There are, I guess, plenty of opportunities now.

Then they have the program where the Corps would send you away to a graduate school. This got more attention, and they started sending a lot of people to graduate school. There were quite a few fellows--I guess some females probably got involved in that, too. I don't know of any of the females that did because there weren't enough of them, but some of them got to go away to school for a full graduate degree.